POWER

Volume 53 New York, January 25, 1921 *Number* 4

Bawling Out

By RUFUS T. STROHM

PERMIT me, reader, to present a very common sort of gent whom I call Lungs O'Leather, whose voice outvies an ass's bray and twenty foghorns down the bay, all trumpeting together.

Because his garret's almost bare of any furnishings but hair, he loves to blare and bellow, believing that a lot of noise will make the simple-minded boys think he's a reg'lar fellow.

By some amazing streak of luck, his job is Grand High Muck-a-Muck down at the power station, and all the time his eyes are peeled for every mishap that may yield some choice vituperation.

Just let the slightest thing go wrong and Lungs O'Leather lopes along, his nostrils breathing fire, and while his palpitating gills go red and white by turns, he spills his vitriolic ire.

He never takes a man aside and in a manner dignified corrects and reprimands him, but then and there, in open view of all the gaping working crew, a bawling out he hands him.

Possessing tact and kindliness of such a brand, you may well guess how much his helpers love him. They love him so devotedly that they'd be crazed with joy to see the daises wave above him!

Armour System of Power-Plant Accounting

By O. A. ANDERSON
Motive Power Department, Armour & Company, Chicago

System of records and accounting from which cost figures are deduced and analyses made of plant operations. The motive-power department has under its supervision 72,000 hp. in boilers burning nearly 900,000 tons of coal and 700,000 bbl. of oil per year. Only 5 per cent of the fuel is burned to generate electric power, the rest being used for refrigeration, air compression, pumping of water and for process work in the slaughtering establishments.

AS ESSENTIAL as was the systematic organization of the packing house during the War, of equal importance was the respective organization of the power plants of the slaughtering establishments. These power stations were taxed to their utmost capacities to meet the demands of the war work, as during this period there was practically no addition in station capacities, making necessary rapid overhauling of equipment during shutdown intervals and careful operation to avoid the seriousness of a long shutdown during the slaughtering periods.

Throughout these plants there is an aggregate boiler capacity of 72,071 boiler horsepower and a total electric generator capacity of 19,000 kw. There is also refrigerating capacity to the extent of 18,841 tons, and capacity in air compressors for 29,000 cu.ft. of free air per minute. During the fiscal year 1919, there was burned in fuel a total of 896,825 tons of coal and 686,056 bbl. of oil. Of the total steam generated, approximately 30 per cent was used in conjunction with the power station supplying the steam ends of ammonia compressors, electric power generators, air compressors and hydraulic pumping machinery. It may be interesting to know that only about 5 per cent of the total fuel burned is used to generate electric power.

Practically all types of boilers are used, varying from horizontal return-tubular in sizes of 125 hp. to water-tube boilers of 550 hp. capacity. In a number of plants situated in the vicinity of the petroleum fields fuel oil is burned. Here good operating results are obtained, the net over-all efficiency from week to week ranging between 76 and 77 per cent. Mechanical stokers are employed in all coal-burning plants having a capacity over 900 hp. In the smaller hand-fired plants it has been found economical to use, generally, forced-draft systems, the area of air openings in the grates depending upon the quality of the fuel burned. In some of these smaller plants test efficiencies covering periods of eight and ten hours range between 77 and 80 per cent. Tests are made on schedule dates every four weeks, the result being that an endeavor is made in the different plants to better efficiencies from time to time, and further, educating the force to better economies in tests naturally reflects in improved economies for every-day operation.

To supply refrigeration there are both compression and absorption plants, the compression system being more generally employed. The absorption system has been installed only in plants where there is an abundance of exhaust steam. In view of the fact that more and more processes in connection with the manufacture of meat, meat products and byproducts are using exhaust steam, most of the steam units of the power houses are being installed for operating either condensing or non-condensing. In this way the functions of the prime movers are more nearly approaching those of a reducing valve between the boiler room and the process machine. In the modern plants, where large freezers are in operation, it has been found economical to operate absorption equipment, using exhaust steam from turbo water pumps, electric-power turbines, air compressors and engine-driven ammonia compressors.

Electrical energy is generated at most of the plants, as central-station power has not been able to compete owing to the extensive use of exhaust steam. In the largest stations 2,300-volt three-phase 60-cycle alternating current is being generated and distributed from transformers for power use at 440 volts and for lighting at 220 or 110 volts. Where direct current is used, power is generated at a voltage of 230.

A large supply of water is used at the packing plants. At the Chicago plant the water consumption approximates 13 million gallons per day. Much of the water is pumped from wells. Where it is in good sanitary condition and does not contain heavy salts, the well water is used for both power-house and factory purposes. Otherwise city water is used.

POWER HOUSE DAILY RECORD

Supt. of Motive Power—Chicago,
Master Mechanic—Plant,

Sirs: The following is a complete report of the operation of the _____ Power House for the 24 hours beginning 7 A. M. _____ 19___

PRESSURES

HOUR	STEAM				VACUUM IN INCHES				Comp. Air	AMMONIA SUCTION PRESSURE — MACHINE OR COMPRESSOR NO.										AMMONIA CONDENSER PRESSURE — MACHINE OR COMPRESSOR NO.									
7 A. M.																												
10 "																												
1 P. M.																												
4 "																												
7 "																												
10 "																												
1 A. M.																												
4 "																												
Ave.																												

TEMPERATURES

HOUR	OUT-SIDE	MAKE-UP WATER	FEED WATER			COOLING TOWER		AMMONIA CONDENSERS								STEAM CONDENSERS				AMMONIA SUCTION TEMP.		AMMONIA DISCHARGE TEMP. — MACHINE OR COMPRESSOR NO.									
						On	Off	On	Off	On	Off	On	Off	On	Off	On	Off	Off	Off	High	Low									
7 A. M.																														
10 "																														
1 P. M.																														
4 "																														
7 "																														
10 "																														
1 A. M.																														
4 "																														
Ave.																														

"X" in first column denotes machine running at beginning of 24 hours. "—" not running at that time. (List All Machines.)

	RATED CAPACITY	STARTED	STOPPED	HOURS RUN	SPEED R.P.M.	COUNTER READING AT 7 A.M.	TOTAL REVOLUTIONS FOR DAY
Ice Machine No.							
Air Compressor No.							

POWER MACHINES	STARTED	STOPPED	HOURS RUN
Power Eng. No.			
Line Shaft Eng.			

	DAY	NIGHT
K.W H. for Power		
" " Light		
Total K.W.H.		

HOUR	VOLTS		POWER FACTOR	AMPERES — GENERATOR No.						
7 A. M.										
10 "										
1 P. M.										
4 "										
7 "										
10 "										
1 A. M.										
4 "										
Ave.										

POWER HOUSE PUMPS	USED AS	HOURS RUN	SPEED R.P.M.	HEAD IN LBS.
PUMP No.				

TOTAL KILL		TONS ICE PULLED		MEN EMPLOYED	DAY	NIGHT	No. & Total HP. Boilers Operated					
Cattle		Clear		Engine Room								
Calves		Car		Boiler Room			7 A. M.					
Hogs		Total		Ice Plant			10 "					
Sheep		TONS ICE IN STORAGE		Pumps			1 P.M.					
		Clear		Temp. Men			4 "					
		Car					7 "					
		Total					10 "					
				Total			1 A.M.					
							4 "					

Remarks, Unusual Occurances, and Repairs Made:	MISCELLANEOUS	PACKING RECORD			
	Lbs. Ammonia Charged	Machine		Kind Packing	Weight

SIGNATURES:

_____ Engineer from _____ to _____

_____ " " _____ to _____

POWER-HOUSE DAILY RECORD USED BY THE STEAM PLANTS OF ARMOUR & CO.

Large quantities of steam are supplied for cooking, heating and drying purposes, and every effort is being directed toward the use of exhaust steam for these purposes, as the higher efficiency obtained will reflect on the cost of production.

Program of Efficiency

From this general survey of the enormous quantity of energy generated and consumed in the packing plants, it will be apparent that careful design and execution of engineering economies must be effected. This program of efficiency is carried out by means of a system of reports which is in operation at all the packing plants. These reports are nothing more than accounting and operating records which anticipate the cost of generating and distributing all the motive-power energy two weeks in advance of the closing of business for each period of the fiscal year. Subsequently, these figures are applied to the actual expense of operating the motive-power department and are then distributed to the various departments on the basis of meter readings or tests that have been made from time to time.

It will be the writer's endeavor to explain just what procedure of reports is executed to give the desired efficiency of operation and just what distribution of actual expense is made to the operating or product-producing departments.

The fiscal year is divided into six periods and a motive-power report covering each period is made up by each master mechanic for the general superintendent of motive power. This report is made up on eighteen form sheets prepared to give all the operating and cost data for the following branches of the department: Generation and transmission of steam, production and distribution of refrigeration, generation and distribution of power and light, production and distribution of compressed air and pumping of purchased and local water. Copies of these forms and a general analysis of each will appear in the several articles of the series on this subject.

Preparation of the motive-power report is made by the master mechanic from operating data summarized from the power-house daily record and from his accounting records of materials used for repair, records of supplies and record of labor used on repairs as received from the construction and repair department.

Power-House Daily Record

The accompanying power-house record is an unusually complete log sheet for which the chief engineer of each shift is responsible. Every three hours readings are taken of pressures on boilers and ammonia compressors, revolution readings and all other operating data. One copy of this report is retained by the master mechanic and a second copy is forwarded to the superintendent of power and filed for reference. From this record the master mechanic can prepare his motive-power report, calculating the production of steam, electric power and light, refrigeration, etc. It also offers a ready means of checking neglect, serious errors and avoiding accidents, as any peculiar recurrence of strange readings will invite immediate investigation by the master mechanic.

In the generation and transmission of steam the method of accounting is shown in the accompanying form. Upon examining this form it will be seen that the first item covers data available from the plant and report records. The second item, indicating the quantity of coal burned and its cost, is carefully determined. In reporting the number of tons of coal burned, actual billing weights are used and a careful inventory is made at the end of the period at 6 p.m. Saturday night of the last week of the report. Actual measurements are made to calculate the weight of the coal on hand; test weights on measured volumes are periodically taken to make sure the correct weight per cubic foot is being used.

Referring to item 5, the average evaporation from and at 212 deg. F. represents the average evaporation obtained from actual boiler tests for each grade of fuel used. As stated previously, a boiler-test calendar is prepared for all the plants and tests are conducted on the same day. The calendar schedule was adopted to facilitate the making of coal analysis in large numbers and also to systematize the calculation of the reports as they are received at the superintendent's office. From time to time these tests are verified by testing engineers from the motive-power department in Chicago.

Calculating Factor of Evaporation

Formulas are used for calculating the factor of evaporation on the basis of the temperature of the feed water and the temperature of the steam calorimeter as indicated on tests. A curve sheet has been prepared so that the plants may readily obtain this figure, using the temperature of the feed water as abscissa and the temperature of the calorimeter as ordinates. The second factor of evaporation, 6(b), is filled in by plants having a feed-water meter. In this case the heating of feed water to 210 deg. will appear as a part of the boiler function, this being done to facilitate the handling of these figures.

Item 7 indicates the evaporation as determined from the feed-water meters. A feed-water meter is installed in most of the large plants, so that a continuous record of boiler operation is obtained.

The unit of steam production adopted is a boiler horsepower-hour, or 34.5 lb. of steam from and at 212 deg. F. When no meter is in operation, the total production of steam in boiler horsepower-hours is calculated from the quantity of fuel burned during the period, referred to the evaporation per unit of fuel given under item 5. It will be noted that a boiler horsepower-hour production is shown as item 8(b). This is calculated on the basis of the heat units given to the feed water by the feed-water heater, referred to an equivalent evaporation of 34.5 lb. of steam, or 33,500 B.t.u. Items 8(a) and 8(b) are added together to give the total boiler horsepower-hours produced. At the plant where feed-water meters are in operation, this figure is determined in one operation by applying the factor of evaporation referred to the temperature of the water to the heater, to the feed-water meter figures.

Item 9 indicates the steam used in the boiler room. Some of these values are calculated on the basis of tests and others estimated according to good practice with respect to rated steam-consumption figures. Summarizing the steam used in the boiler room and deducting from the total steam produced, gives the total net steam produced or delivered from the boiler room in boiler horsepower-hours.

The three succeeding items represent the cost of motive-power energy used in the boiler room, other than steam. The quantities are estimated or determined by test depending upon the data available for estimating. The cost, however, is determined by the multiplication of the number of motive-power units by the units cost as obtained from the report for the previous period.

Beginning with No. 15 the remainder of the items represent actual expense in dollars and cents incurred in the operation of the boiler room. A careful check on the labor employed from period to period is maintained by the executive in charge. The compilation of the data alone makes a step toward efficiency, as all labor, both regular and extra, must be accounted for. Further, every endeavor is made to retain the respective labor costs at the various plants at a minimum, due to the comparative standing that is indicated in the summarized comparisons which are made from these reports and later distributed to all master mechanics.

On the cost of supplies the same efficient check is maintained. It is the practice to send a detailed, comparative report on consumption of lubricants, a tabulation being made giving the consumption and cost of cylinder oil for each plant per million square feet of cylinder-wall area traversed, consumption and cost of engine oil per 1,000 hp.-hr. developed by the prime movers. These comparisons offer incentive to bring these costs to a minimum

The foregoing is equally applicable to cost of repairs. In addition to this, however, much good information is derived from such data, as they give a check on the comparative cost of upkeep for varied equipments at the different plants. Further, a review of these costs will disclose the source of most of the troubles in the boiler room, so that the master mechanic can determine quickly where his investigation will do the most good and take steps to eradicate the trouble if possible. These figures also assist in governing future design and purchases.

Reference to the last items will show them to be self-explanatory. Mention need only be made that the inclusion of overhead charges is necessary to give the true operating expense.

Summing up all of the costs tabulated and dividing by item 10, the total net boiler horsepower produced, will give the unit cost of steam for the period reported. This figure represents the cost of steam leaving the boiler nozzles for distribution to the engine room and factory. As previously stated, comparative statements are made showing the cost of steam production in the different plants and also showing the comparative cost of steam from one period to another. Further, as changes in prices of one fuel compared to another develop, the facts are immediately reflected in the unit cost of steam and steps are taken to change the kind of fuel, which also may involve a change in the furnace and the fuel-handling equipment. These steps are borne out, however, by the better economies shown in subsequent plant records.

Generation and Transmission of Steam

Motive Power Dept.

Plant.....
Report for_____weeks ending_____191_____

1. Plant capacity
   - (a) Number boilers in plant.....
   - (b) Total rated horsepower.....
   - (c) Avg. rated hp. in operation.....
   - (d) Total rated hp.-hr.....
   - (e) Total b.hp.-hr. produced (Item 8a).....
   - (f) Avg. per cent rating developed.....
2. Tons coal burned, kind coal, and cost.....
   - (a) _____ Tons of _____ @ $ _____ per ton.....
   - (b) _____ Tons of _____ @ $ _____ per ton..... $_____
   - (c) _____ Tons of _____ @ $ _____ per ton..... $_____
   - (d) _____ Tons of _____ @ $ _____ per ton..... $_____
   - (e) _____ Tons of _____ @ $ _____ per ton..... $_____
   - (f) _____ Total tons coal. @ $ _____ Avg. per ton.. $_____
3. Fuel oil burned
   - (a) Total number barrels.....
   - (b) Average degrees Baumé.....
   - (c) Average weight per barrel.....
   - (d) Number tons oil burned.....
   - (e) Average cost per barrel..... $_____
   - (f) Total cost oil for fuel..... $_____
4. (a) Average temperature water to boilers.....
   (b) Average temperature supply to heater.....
5. Average Evap. F. & A. 212 Deg., Shown by Boiler Tests:
   - (a) Kind coal _____ Evaporation _____
   - (b) Kind coal _____ Evaporation _____
   - (c) Kind coal _____ Evaporation _____
   - (d) Kind coal _____ Evaporation _____
   - (e) Kind coal _____ Evaporation _____
   - (f) Average in proportion to different coals burned.....
   - (g) Average evap. f. & a. 212 deg. from tests with oil.....
6. (a) Avg. factor of evaporation from tests.....
   (b) Avg. factor of evaporation based on temp. to heater.....
7. Data from feed-water meters
   - (a) Total actual lb. evaporated.....
   - (b) Total lb. evaporated f. & a. 212 deg.....
   - (c) Lb. evap. f. & a. 212 deg. per lb. coal.....
   - (d) Ratio item (7 c) to (5 f or g).....
8. (a) Total b.hp.-hr. produced in boilers.....
   (b) Total b.h.p-hr. produced by heater.....
   (c) Total b.hp.-hr. produced.....
9. B.hp.-hr. used in boiler room (take ½ total calculated, if exhaust goes to heater)
   - (a) Filter pumps.....
   - (b) Heater.....
   - (c) Boiler-feed pumps.....
   - (d) Stoker engines.....
   - (e) Steam jets.....
   - (f) Atomizing oil.....
   - (g) Boiler wash pump.....
   - (h) Oil pumps.....
   - (i) Heating feed water.....
   - (j) Heating fuel oil.....
   - (k) _____.....
   - (l) _____.....
   - (m) Total for boiler room.....
10. Total net b.hp.-hr. produced.....
11. (a) Total gal. feed water to boilers.....
    (b) Estimated gal. trap disch. ret'd to heater.....
    (c) Gal. condensate from exhaust steam to heater.....
    (d) Total gal. from feed water supply.....
    (e) Cost feed water per M. gal..... $_____
    (f) Total cost feed water..... $_____
12. Electric energy consumed in boiler room
    - (a) Coal conveyors _____kw.-hr. @ $ _____ per kw.-hr.... $_____
    - (b) Ash conveyors _____kw.-hr. @ $ _____ per kw.-hr.... $_____
    - (c) Blr.-rm. lights _____kw.-hr. @ $ _____ per kw.-hr.... $_____
    - (d) Stokers _____kw.-hr. @ $ _____ per kw.-hr.... $_____
    - (e) ..... _____kw.-hr. @ $ _____ per kw.-hr.... $_____
    - (f) ..... _____kw.-hr. @ $ _____ per kw.-hr.... $_____
    - (g) Total..... _____kw.-hr. @ $ _____ per kw.-hr.... $_____
13. (a) Estimated M. cu.ft. free air for boiler cleaning.....
    (b) Total cost compressed air for boiler room..... $_____
14. Water for boiler cleaning
    - (a) Source.....
    - (b) Discharged to.....
    - (c) Total M. gal. used.....
    - (d) Charge per M. gal..... $_____
    - (e) Total charge..... $_____
15. Cost of labor for operation
    - (a) Boiler-room portion of engineer's wages_____%..... $_____
    - (b) Unloading fuel from cars..... $_____
    - (c) Handling to bunkers or firing floor..... $_____
    - (d) Firemen and water tenders..... $_____
    - (e) Handling ashes..... $_____
    - (f) Boring boilers..... $_____
    - (g) Cleaning furnaces, tubes and breeching..... $_____
    - (h) Feed water treating..... $_____
    - (i) Janitor service..... $_____
    - (j) Testing..... $_____
    - (k) Reports..... $_____
    - (l) _____..... $_____
    - (m) ..... $_____
    - (n) Total cost labor for operation..... $_____
16. Supplies
    - (a) Lubricants _____ gal. of _____ @ $ _____ per gal. $_____
      _____ gal. of _____ @ $ _____ per gal. $_____
      _____ gal. of _____ @ $ _____ per gal. $_____
      _____ gal. of _____ @ $ _____ per gal. $_____
    - (b) Waste..... $_____
    - (c) Packing..... $_____
    - (d) Gage glasses..... $_____
    - (e) Boiler compound: _____lb. of _____ @ $ _____ per lb. $_____
      _____lb. of _____ @ $ _____ per lb. $_____
      _____lb. of _____ @ $ _____ per lb. $_____
    - (f) _____..... $_____
    - (g) _____..... $_____
    - (h) Total cost supplies..... $_____
17. Repairs
    - (a) Replacing tubes in boilers..... $_____
    - (b) Repairs to shells, water columns, gages, etc..... $_____
    - (c) Repairs to boiler-room piping..... $_____
    - (d) Repairs to feed pumps..... $_____
    - (e) Repairs to other boiler-room pumps..... $_____
    - (f) Repairs to furnace brickwork and supports..... $_____
    - (g) Repairs to stoking apparatus and grates..... $_____
    - (h) Repairs to fuel-handling machinery..... $_____
    - (i) Repairs to ash-handling machinery..... $_____
    - (j) Repairs to boiler-room tools..... $_____
    - (k) Repairs to setting..... $_____
    - (l) Repairs to main lines outside boiler-room..... $_____
    - (m) Repairs to bunkers..... $_____
    - (n) Repairs to feed-water heaters..... $_____
    - (o) Repairs to feed-water treating plant..... $_____
    - (p) Repairs to _____..... $_____
    - (q) Repairs to _____..... $_____
    - (r) Total cost repairs..... $_____
18. (a) Total cost of boiler-room, complete..... $_____
    (b) Annual rental charge, 6 per cent..... $_____
    (c) Annual depreciation charge, 5 per cent..... $_____
    (d) Rental charge for period..... $_____
    (e) Depreciation charge for period..... $_____
    (f) Boiler insurance..... $_____
    (g) Taxes..... $_____
19. Credit for cinders sold..... $_____
20.
21.
22.
23. Total net cost fuel, water, electric power, compressed air, labor, supplies, repairs, rent, depreciation, insurance, taxes..... $_____
24. Total cost per net b.hp.-hr. produced..... $_____

Unusual Experiences in Steam Engineering in France

By CARROLL F. MERRIAM

LANGRES is a city essentially a fortress from the earliest days of history. It is situated high above the surrounding plain and is isolated from the rest of the world through the lack of adequate transportation and the almost entire absence of industry.

The fundamental obstacle with which we had to contend, was the element of unprogressiveness. What had sufficed in the past was considered good enough for the future. This applied to the supply of water; unaffected by modern notions of sanitation and public health, the abundant use of water is still considered with indifference. Therefore the water consumption per inhabitant would naturally be small compared with our standards, and one can readily see why they should still hold to the small antiquated pumping station that we found.

The second obstacle was that we were dealing with military authorities who had not awakened to the gravity of the situation of, say, doubling the population with an influx of soldiers, who habitually used quantities of water for drinking, cooking and washing, when the supply was hardly more than enough for the civilians. Anyone who knows red tape can appreciate the position of enlisted men with a task set before them, but with no authority to do anything. We were also dealing with civil authorities who had little appreciation of engineering and with men who understood very little of what we were about.

During the world war the writer of this article was sent to Langres, Haute-Marne, France to take charge of a detail of men commissioned to make the necessary repairs at the city pumping station. Although this was not as exciting as trench digging and barbed-wire work, still it threw him in contact with engineering under circumstances which are not common in the United States.

The third obstacle was the lack of materials, supplies and tools. To get French supplies would have meant to order that with which we were not familiar and always with the uncertainty as to when delivery would be possible, if at all. American supplies were not available at that time, and even if they had been, there would always have been the question as to the best way to make the English sizes fit the metric. The only tools that we had were those we happened to find on the job and they of course were, to our hands, clumsy and awkward.

The first difficulty in providing a water supply lay in the situation of the city, high above the level of the springs on which the supply depended. After crossing a valley, the aqueducts that brought the water ended in a reservoir located more than a hundred meters short of the elevation of the city. On the side of this was the pumping station to raise the water the remaining distance, operating under a combined static and friction head of about 390 ft., rather above our ordinary practice. To say the least, supplying water under these conditions was costly and even small leaks were of great importance.

A further difficulty lay in the cost of coal and the impoverished condition of the city treasury; during the winter season, when the canal was frozen and the railroads rushed to the limit to carry food and war materials, it was practically impossible to get it at all. Coal at that time ranged the equivalent of from $17 to $21 a long ton.

Plant Equipment

In general, the plant was a small one, its equipment consisting of three boilers and the pump. The building contained the pumproom, shop and living quarters on one level, the boiler room located about ten feet lower on the downhill side of the station. The level of the water in the reservoir was several feet lower than the cylinders of the pump, a fact that we had many an opportunity to regret when trying to get the pump to "lift" water.

One boiler was somewhat similar to our horizontal return-tubular, except that two drums were used below the shell. The hot gases make three passes, first under these heaters, then over them and lastly through the tubes to the chimney at the rear. The damper was a plain iron slab that rose and fell in a slot in the flue like a theater curtain. This boiler was built for 172 lb. pressure and contained about 1,180 sq.ft. of heating surface. A plain herringbone grate with about 43 sq.ft. of area was used.

The other two boilers, much smaller, were unlike anything else I have ever seen. They were something after the pattern of a Scotch marine. The main difference being that they "took apart." The front tube sheet, the single furnace—which was simply a plain cylinder unstrengthened by either corrugations or a ring—the tubes and the rear tube sheet, to which was bolted a forged "dish" which formed the combustion chamber, all made one unit which entered the drum on a track and was bolted to the heavy flange of the shell. The advantage was that it could be cleaned in comfort after all those bolts had been taken out. It could be put back into service after that big bolt circle had been packed steam tight. The near head was dished convex to withstand the pressure, there being no stays. These boilers were designed for 87 lb. pressure. The hot gases issuing in this case from the front of the boiler were taken by a "downtake" through an underground passage to the chimney. On account of the impaired draft, one of these boilers was useless without the other, which had been damaged as a result of low water and a drunken fireman.

The pump consisted of a twin horizontal simple engine with the pump rods keyed to the ends of the tail rods. The steam cylinders were about 10 in. in diameter and the stroke was very nearly 22 in. The

normal speed was supposed to be 50 r.p.m., running under. The valve gear was apparently an ordinary slide valve with some kind of a trip inside the valve chest which was supposed to vary the cutoff. It was evident, however, that this did not work as no difference could be noticed in the exhaust between full stroke and one tenth cut off.

The water side consisted of two cast-iron cylinders on each side, each pair with a single 4-in. plunger. The valves, different from anything that I had ever seen before, were built up of four heavy brass castings and stood about a foot high and eight inches in diameter. The body formed the seats, not only for a valve disk on top, but also an annular seat for a valve in the shape of a sleeve which slid up and down on the cylindical part of the body. A threaded ring or nut was used to regulate the height of the lift of this outer valve. The little disk on top was held from rising too far by regulating screws projecting down through the top of the casing. Another interesting feature was that of the eight valves, no two of which were interchangeable. The water discharged from the valve chambers passed first into two great cast-iron domes, about 12 ft. high, which were supposed to be filled with air. The gage glasses on these had long been broken, and leaks had developed so high up that nobody paid much attention to whether there was air there or not.

The discharge from each side had its own shutoff so that one side could be run independently of the other, if necessary. These valves were of the non-rising stem type with no telltale and opened just opposite to ours, as was clearly impressed on me after starting up with one closed.

The auxiliaries consisted of two eccentric driven condenser pumps. On one side the condenser had been discontinued and the eccentric strap dismantled. On the other side the vacuum gage showed a periodic fluctuation from zero up to 60 cm. (23 in) followed by a sharp click in the pump and then a sudden slump to zero—a pretty good sign that something was not right.

Formerly, the two crosshead pumps had been connected to supply hotwell water to the boilers, but apparently somebody had carelessly shut off the discharge and found that it didn't stop the engine. It was in any case considered safer, even if not economical, to take the water directly from the mains, as the pressure there was almost always greater than that in the boiler. As it happened, the one time that it wasn't, was when we had low water and no other means of feeding the boiler. It was a close call that night, but even that example would not convince the engineer that he needed any provision for such an emergency.

Needs of the Plant

With the station in the condition that we found it, there was a pressing need for three things: More capacity; an increase in efficiency to conserve as far as possible the meager supply of coal; and safety, to prevent as far as possible an accident which would put the station out of commission.

In regard to capacity the dimensions of the cylinders and the speed showed that the pump had a piston displacement equal to 218 gal. per minute, or in the course of a day, neglecting leakage and slip, should deliver nearly 1,200 cubic meters, or 315,000 gal. Rough estimates of the amount of water used by the city showed that only about half of that figure was being received at the reservoirs.

To save as much as was possible of this loss would in itself greatly increase the capacity. The most visible sign of a loss was the general appearance of a shower bath about the water cylinders. The main packings were fairly tight, but the pump rods were so badly worn that nothing that we could put in would be tight. Occasionally, a stuffing-box packing would blow out altogether, causing a little excitement. The leakage ran into a common drain so that it could be measured by timing the filling of buckets and then weighing them. In this way we found to our surprise that this water, most of which flowed in a river across the boiler-room floor, amounted to a loss of four hours' pumping in every twenty-four.

Our general crusade against leaks was considerably hampered by the fact that it took three days of forced operation to get enough water in the reserve to be able to shut down for a few hours. In the meantime the fountains played in the city and in the barracks there were two big leaks, but this was beyond our jurisdiction and nothing could be done.

By picking our time as best we could, we were able to accomplish considerable in the way of packing stuffing boxes and valve bonnets. Around the discharge valves on the cylinders were a number of small bypasses which gave considerable trouble, as the cocks had been scored and there wasn't much stock left to ream out or grind. Furthermore, it was very hard to make any packing that we had on hand, or could get hold of, stand the pressure for any length of time.

From what we could see of the condition of the pipe line before it left the building, it was easy to judge in what shape we should have found the line running up to the city had we been able to dig it up. The leakage forced to the surface on the steepest part of the slope coursed down, making a little brook.

Defective Valve Caused Loss of Capacity

Another important cause for loss of capacity was the failure of the clumsy brass valves to seat properly. Two in particular gave much trouble. One of them would put one cylinder out of commission until someone happened to discover that there was an air pressure in the suction pipe instead of a vacuum. This air would be drawn through a leaky stuffing box on the suction stroke and then be driven back past the leaky valve into the intake. Needless to say, the cylinder did little work even under the best of conditions. On another cylinder there was a discharge valve that operated intermittently, frequently sticking open and then freeing itself. As the pump was without a governor, the action of this valve was clearly felt on the speed of rotation.

Increased capacity could, of course, be obtained with higher speed, but with the danger of something giving way, we never encouraged the attendant to increase his normal number of turns. The firemen saw to it that the counter was out of commission so that there was no check on their work, and consequently while cleaning the fire they would allow the pump to slow down so that I doubt very much if it was delivering a drop of water. At times of low pressure there was still plenty of power to be had by opening the throttle, but this operation was beyond the grasp of the operators' minds.

The pump was originally equipped to run condensing, but its performance was very poor. The thermal efficiency was lower than that which would have been expected from a very poor locomotive.

The loss in efficiency could be traced fundamentally to a fault in design. To deliver 218 gal. a minute under a head of 390 ft. requires, in the first place, but 21.4 hp., theoretically. For this work the engine used would be rated as 44 hp. under the laws of Massachusetts. To generate the necessary steam we would rate the boiler at 118 hp. The fact that this boiler at times had hard work to keep the pump up to speed was certainly an indication that everything was not as it should have been.

Perhaps the primary reason for this steam loss in efficiency was the multitude of leaks in the steam line. Practically every joint had gone, and as fast as we could pack them with sheet asbestos, the only thing available, they would give way again. If we did get them tight, a leak would develop between the flange and the pipe. This meant that the section would have to be taken down and rebrazed, as this was our only way of making the flange stick on to the end of the pipe. The worst leak of all was between the boiler and the stop valve, and this of course we could not touch until the boiler could be spared, a condition that never occurred during our stay, as one small boiler alone could not carry the load and the other was just being shipped for repairs.

To reduce the importance of these leaks, we tried to get the fireman to run with lower pressure and a wider throttle opening, but his knowledge of steam engineering did not allow any such refinements as that, and he objected to anything that would confine his attention to the plant to the exclusion of the café.

Pumps Needed Packing

To explain the strange action of the vacuum gage, we found that all the piston packing in the pumps was gone and both pistons were badly worn. We salvaged enough parts out of the two to make one fairly respectable pump with the exception of packing which was ordered. We hoped that with one condenser in commission, we would be able to get this side to take the greater part of the load and use the exhaust of the other side in the remains of a primitive feed-water heater, and thus secure a thermal balance that would have been the envy of all the big central stations in America. The packing, such as it was, came—a hard rubber ring about an inch too small in diameter and about two inches too wide. Further correspondence resulted in nothing, so our plans were frustrated.

A considerable loss of steam was caused by the engine being out of line. The crosshead jumped from guide to guide, making satisfactory packing of the stuffing boxes impossible, until the adjustments could be made. The valve stems were most pitiful examples of neglect and lack of oil. The glands were not a part of the original machine, having been stolen from one of the city's locomotives. The oil box, which was cast integral with it was turned in a horizontal position and useless. The wear had actually reduced this rod to about half its former area, so that in spite of what we could do it always blew steam.

The system of cylinder lubrication consisted of a little brass globe on each end of the cylinders. This was closed by two cocks, the idea being that oil could be trapped in the same way that a man passed through an air lock. In the event of the lower cock not holding, the job of fillling such a lubricator is not to be envied. Furthermore, it is evident that the "buttering" of the cylinder was not very complete and the effect of such a system must have been felt after years of service.

There was no feed pump in commission and as it was winter it was necessary to use practically ice-cold water. The argument that ten degrees was equal to one per cent certainly applied, but neither the value of this saving nor the probable effect on the boiler seemed to appeal to the French.

Moreover, this cold feed water was all raw water from springs in a limestone country, so that formation of considerable scale was pretty sure to occur. The boiler had already been in service for some length of time and had never been blown down. Judging from the looks of the mess that formed around the leaks about the manholes, cleaning was badly needed, but with no spare boiler in sight for months, we just had to keep on going regardless of economy or safety. The tubes were blown daily, but the leak in the valve to the blower wasted a good part of the savings.

Efficiency and Safety

Conditions were certainly bad in regard to capacity and efficiency, and safety seemed to be the last consideration. In the first place the firemen, who were the only ones who constantly attended the plant (and they sometimes took little vacations), apparently knew next to nothing about the engine. One of them, no matter what the emergency, could do nothing on his own initiative. He was helpless when a joint in his feed line began to give way, shooting boiling-hot water back past the check valve into the boiler room. To shovel coal and pick specks of coke out of the ashes was just about the extent of his ability.

The safety valve was an old weighted affair which was never lifted to see that it was free. If this was in keeping with the rest of the plant, I am sure that it would have been found well corroded. Inasmuch as the pressure ordinarily carried was about half that for which the boiler was built, we decided to let well enough alone and not bother with it. I am satisfied that the leaks in the steam line and the lack of ambition on the part of the firemen would limit the pressure to well within the safe range.

The water column did not have to be blown down, as that had long since ceased to be used. Instead, a float was depended upon to give indications of the water level. This device, which I have found quite common in France, consisted of a rod attached to the float projecting in a casing above the shell of the boiler. On this was a magnet which attracted a little iron roller on the other side of a brass plate, on which was a scale. The movement of the float was thus reproduced on very much the same principle as the movement of the pointer of a steam-flow meter. The reliability of such a device is certainly questionable, as any number of things might result in a false reading without any way of verification.

As might be expected, the chief source of danger about the engine was the flywheel, which had a jointed cast-iron rim rotating pretty close to the safe limit, considering that the journal boxes were badly worn and the shaft jumped about considerably. Just what side strains this was setting up I do not know, but it used to give me the shivers to think what might happen if the engine started to race with no governor to hold it down.

The wobbling of the shaft was so severe that it had loosened the keys, and so the wheel was free to roam from one side of the wheelpit to the other. Whenever it

would reach the edge of the pit, it would start to chew away on the brick walls until the fireman would come and shut down, and wait for the engineer to push it back into place with ordinary machine bolts of assorted sizes.

This is, in brief, the problem that confronted us and upon which we made comparatively very little progress. Just as General Headquarters was beginning to see that some definite step must be taken, we were relieved to be sent to the front with our division. Somewhat later a regular detail of engineers came to take over the station. American supplies could then be had on requisition, so that they were able to do good work in getting things into shape. A little duplex pump of capacity equal to, if not better than, that of the big pump was installed to take its place while the necessary repairs could be made. A new steam line with flanged joints screwed, not held by faith and friction, to the pipe cut down the losses considerably. The other little boiler finally came back, which allowed the big one to be gone over and cleaned.

Plant Still Running

I have since visited the plant and found the old pump still running and the flywheel hasn't gone up yet, although the city has not seen its way clear to get a governor. The wear has been taken up, which adds greatly to the smooth running qualities and the stuffing boxes are kept tight. One side is running condensing, when there is sufficient cooling water, but the other pump is too far gone to do anything with. An engineer is now on duty for this particular plant, so that he does not have to trust it to the fireman.

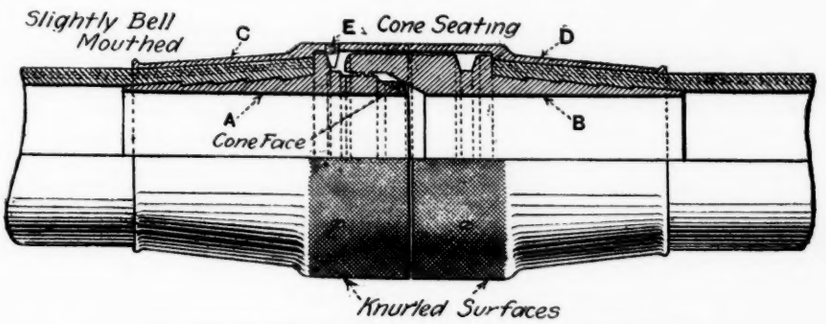
Our administration was not without some excitement like low water, pump refusing to prime, broken feed pipe, flange stripped off a length of steam main, bolt working loose and flying out the top of a valve case, fireman falling down a trap door, stuffing boxes blowing out and many other incidents to add a little spice, but we were always lucky to get by without having to interrupt service.

New Hose Coupling

A new hose coupling, the invention of E. Barnfather, has recently been placed on the market by the Consolidated Pneumatic Tool Company, Limited, and is described in *The Engineer*, London. The coupling is designed to suit all sizes and varieties of either rubber or metallic hose. The form used for rubber hose, shown herewith, consists of two spigots *A* and *B*, made of extruded bronze, and two sleeves *C* and *D*, of mild steel To attach the coupling to the hose ends no tools other than a screwdriver are required. The sleeve *C* is first of all passed on to the hose. Thereafter the spigot *A* is pushed home into the bore of the hose. The sleeve is then drawn up into position, the final pinch being given by inserting the three taper-pointed grub screws *E*. The grub screws thereafter securely hold the sleeve in position relatively to the spigot, while the serrations on the spigot prevent the hose from being drawn out. The spigot and sleeve *B*, *D* are applied to the end of the other hose length in the same way.

The coupling up of the two hose lengths is effected by giving them a preliminary twist in opposite directions, inserting the one spigot within the other, and screwing the ends round so as to engage the threads on the spigots and cause the cone face on the end of the spigot *A* to make tight contact within the conical bore of the spigot *B*. The correct angle for the conical faces has been carefully studied, and has been found to be 26 degrees.

The features claimed for the coupling are its simplicity, the smoothness of its exterior, the ease with which the coupling up can be done without the use of tools, and the attainment of tightness by means of a metal-to-metal joint without relying on leather or rubber washers. The coupling, it is said, has successfully withstood a pressure of 500 lb. per sq.in. without showing signs of leakage or of being about to be blown off the hose. It is pointed out, in addition, that the coupling is self-protected against accidental damage. Thus the thread and cone face of the spigot *B* are internal, while on the spigot *A* they do not project as far as the mouth of the sleeve *C*. The outer ends of the spigots and sleeves, it will be noticed, are bell-mouthed or radiused to avoid the cutting of the hose.



SEMI-SECTIONAL VIEW THROUGH HOSE COUPLING

Adjusting Oil-Engine Valves

In setting the various valves, the flywheel should be turned ahead until the desired opening or closing point is reached. The valve nut should then be adjusted so that the valve stem can be turned by the hand.

The clearances given by the engine builder are correct for new engines. It is well to remember that cams and gears wear, thereby altering the valve setting.

The fuel valve requires but a slight amount of grinding. A mere hair-line contact is better than a broad ground surface.

If a fuel oil is very thin and tends to enter the cylinder at too high a rate, use more discs in the atomizer and reduce the air-blast pressure.

In setting the fuel-valve timing, remove the indicator plug. Open the air injection valve a slight amount. Then turn the flywheel to the injection point and change the position of the needle-valve adjusting nut until the blowing of the injection air can be barely heard when the ear is placed at the indicator opening.

In cases where the fuel-valve stem corrodes from sulphur in the oil, bronze stems with a steel tip will eliminate the trouble.

If excessive air-injection pressure is carried, the efficiency is decreased and the engine tends to pound.

In tightening up valve-cage bolts, a hard blow may snap the bolt. The extreme variation of temperature the bolts undergo often crystallizes them.

Measurement of Load on Large Water-Wheel Driven Alternators

By C. W. Leonard

EFFICIENCY tests on large waterwheel-driven generating units cannot be made at the place of manufacture, on account of difficulties in securing a suitable load and complications of assembly where parts of units are purchased from different manufacturers, so that if tests are required it becomes necessary to make arrangements for them after the installation of the unit at the plant.

In addition to making water measurements accurate determinations of load on the unit are essential, and these can be obtained conveniently and accurately from a summation of the generator output and losses. It is necessary to have some means for adjusting the generator load to the fractional values desired on the efficiency curve for the prime mover and for holding the load constant while taking readings. On many power systems this can be accomplished by definite settings of the governor, with arrangements for other generating plants connected to the system to take care of fluctuations. In isolated cases, securing the desired steady load sometimes becomes a problem where recourse must be had to energy-absorbing devices such as water rheostats, of sufficient capacity to take care of all or a substantial part of the load.

Discusses measurement of load on large waterwheel-driven units after installation as required for efficiency test, metering arrangement for measuring the output, precautions to be observed, determination of losses and results of test on five-thousand kilowatt unit.

Since practically all modern alternating-current generators are three-phase, discussion will be confined to this type of unit. The most convenient means of securing output readings is to make use of the instrument equipment provided on the generator panels which, if used, should be carefully calibrated before running the test. These should include alternating-current voltmeter, frequency indicator, ammeter, polyphase indicating wattmeter, power-factor indicator and integrating watt-hour meter for armature circuit, also direct-current voltmeter and ammeter for the field circuit. While the calibration of the watt-hour meter is of the greatest importance, the result of slight errors in other instruments may generally be neglected without seriously affecting final results.

The usual type of two-element polyphase integrating watt-hour meter most frequently provided on generator panels will, under favorable conditions, be fairly satisfactory, although more accurate reading will result from the use of three separate single-phase meters connected to measure separately the output of each phase. A very satisfactory arrangement is to provide a set of these meters, in addition to the regular switchboard meter, using the reading of one as a check against the other.

A further refinement, which may be found desirable where important considerations are at stake, such as bonus and penalty on prime-mover efficiency, is to use three single-phase watt-hour meters with separate current and potential transformers, all specially calibrated for the test. Since it is difficult to summarize the readings of the three meters, it will be found convenient to take advantage of the polyphase meter on the switchboard, which may be adjusted to the correct value by comparison with the three test meters by means of time-load generator runs. Readings required will be either momentary or of considerable time duration according to the method for measuring input. If momentary values are desired, they are best taken from the indicating wattmeter and from the watt-hour meters by counting and timing the meter disk revolutions. Two stop watches will be found preferable for the latter readings, which may be reduced to kilowatts by means of some of the well-known meter-calibrating formulas, depending upon the make of meter under consideration. Readings of longer duration are best obtained from the watt-hour meter, preferably by counting disc revolutions and measuring time unless special dials capable of being closely read are fitted to the meters.

As a precaution all watt-hour meter readings should be carefully checked against the average of a series of indicating watmeter readings taken at a rate as rapidly as recording will permit. Some advantages may be secured in obtaining indicating readings if a good dead-beat portable indicating wattmeter is connected in place of the usual switchboard instrument.

In making such special tests as the foregoing, where additional instruments are placed in series with the current circuit of the regular switchboard equipment, care must be taken to see that current transformers are not

loaded beyond their rating, resulting in errors due to change in ratio. It is also important to remove from the current circuits of the instrument any inductive equipment such as relay coils, which would introduce phase-angle errors.

Where overloading of current transformers is necessary, correction curves, showing the ratio with different values of secondary load, should be made in advance of

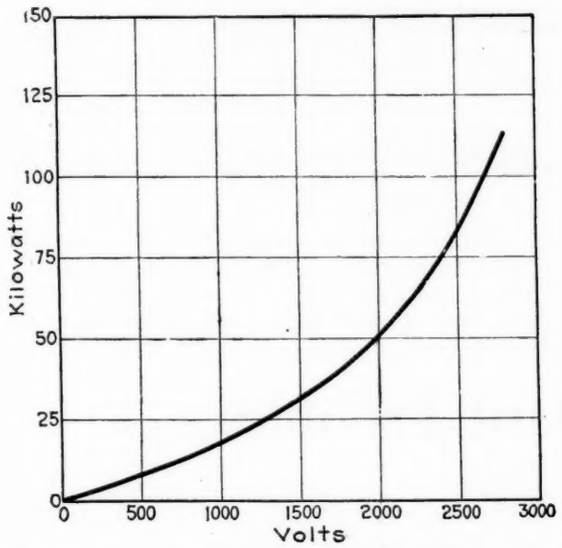


FIG. 1. TYPICAL OPEN-CIRCUIT CORE-LOSS CURVE

the test and the different readings corrected for ratio, where necessary. With good standard commercial instrument transformers, errors due to phase displacement need not be feared where conditions are fairly normal and power factor reasonably high.

While taking load readings, simultaneous readings of field volts and amperes must be secured, also temperature of armature windings, which is necessary for a determination of the generator losses.

If the unit is provided with a direct-current exciter, the temperatures of this unit must also be secured, as they will be necessary to determine the main-unit output, unless a suitable efficiency curve is available.

During these tests the voltage and frequency should be maintained at the normal and the power factor adjusted to as near unity as possible, all of which will be conducive to the securing of good results. All the foregoing values, also armature amperes, should be read and recorded with their respective load readings. After readings have been secured for the desired points on prime-mover efficiency curve, it will be necessary to determine the corresponding losses which must be added to the output readings, to obtain the total load on the prime mover.

These losses consist of core loss, copper losses, stray-load losses, friction and windage in the generator and also in the exciter if direct-connected. All other losses in rheostats and cables must be considered where they are of sufficient magnitude to influence final results.

One of the losses most difficult to obtain satisfactorily is friction and windage. The method to be followed will depend upon the character and reliability of test data secured on the generator during the shop test.

Friction and windage readings obtained on shop test may be used if known to be reliable. A friction run may conveniently be made in the plant after the unit is installed, provided it is equipped with a suitable direct-connected exciter and means for disconnecting the generator from the prime mover. This is accomplished by driving the unit at full speed, operating the exciter as a motor. The input to the exciter at full generator speed when corrected from the efficiency curve will generally be found sufficiently accurate.

In the absence of a direct-connected exciter, friction and windage can be obtained by driving the generator from a separate, test-rated motor, although this is seldom found feasible on account of inconvenience, cost and other limitations.

In the absence of friction and windage data and local means for securing it, a close approximation can generally be obtained from the manufacturers. It is difficult or impossible to estimate on a percentage basis since the matter of speed and type of bearings used, result in quite wide variations for the same capacity of unit.

Tests on a 5,000-kw. 360-r.p.m. three-phase two-bearing generator with direct-connected exciter showed a combined friction and windage loss of about 1 per cent. Generators of various speeds may show values varying widely from this figure, depending on speed, type of bearing and type of rotor, which in some cases is provided with fans for the purpose of cooling the generator windings.

For a determination of the remaining losses it is necessary to have curves for the generator, showing open-circuit and short-circuit core losses and resistance data for the armature winding at some definite tem-

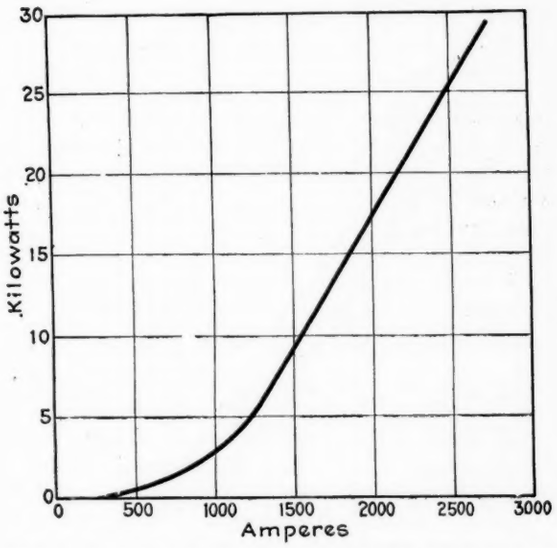


FIG. 2. TYPICAL SHORT-CIRCUIT CORE-LOSS CURVE

perature. Core loss is determined from the open-circuit core-loss curve and should be read at the operating voltage obtaining during the test.

Fig. 1 shows a typical open-circuit core-loss curve which was obtained by driving the generator from an independent motor, with rating specially determined for the purpose. Motor input readings were taken at fractional field excitation values and without excitation. The latter include friction and windage and when deducted from the former give the values for open-circuit core loss which are plotted to obtain the curve.

Stray-load losses in synchronous generators according to the standardization rules of the A. I. E. E. "include

iron losses, and eddy-current losses in the copper, due to fluxes varying with load and also to saturation." It is further stated that "stray-load losses are to be determined by operating the machine on short-circuit and at rated current. This, after deducting the windage and friction and I^2R loss, gives the stray-load loss for polyphase generators and motors."

The typical short-circuit core-loss curve shown in Fig. 2 is based on data secured as previously explained. Values from these curves are used in the example cited herein.

The I^2R or copper losses are determined from the resistance of the windings at the temperature at the time of test or direct from instrument readings where possible.

These losses, when added to the output as measured, give the total load on the prime mover, which, when converted to horsepower, is the value to be used as the total mechanical output of the unit.

The following data applying to a 5,000-kw. 2,300-volt 360-r.p.m., three-phase generator with separate excitation will illustrate the method to be followed, which is worked out below for the full-load reading at unity power factor.

Resistance of armature per phase corrected for temperature	0.01098 ohm
Resistance of field corrected for temperature	0.396 ohm
Armature current at 5,000 kw. 1.00 power factor	1,256 amp.
Field current	209 amp.
Friction and windage of generator from test	49.5 kw.

From the foregoing the total mechanical output of the waterwheel with 5,000-kw. generator output is equivalent to the following:

	Watts
Core loss at 2,300 volts, from open-circuit core-loss curve	67,500
Load losses at 1,256 amp. from short-circuit core-loss curve	5,300
I^2R armature loss is $\overline{1,256^2}\ \frac{(0.01098 \times 3)}{2} =$	25,970
Friction and windage of generator from test	49,500
Total losses in watts	148,270
	Kw.
Generator output from watt-hour-meter reading	5,000
Total losses	148.27
Total water-wheel output	5,148.27
Total water-wheel output in horsepower	6,901.

With direct-connected exciter the I^2R alternator's-field, field-rheostat losses and exciter losses would be added to the data given. These are nearly equal to the exciter output corrected from the exciter efficiency curve.

Refrigerating-Plant Troubles

BY J. C. MORAN

A FEW weeks ago I was called in to solve an unsolvable case of pounding in a 100-ton vertical single-acting compressor. The pound seemed to take place in one cylinder just after the crank had passed the top center and was fairly started on the down stroke. The machine had just been opened up and overhauled, the cylinders rebored, the false heads and valves ground in and refitted, and according to everybody's opinion the machine should have run like a brand new one.

The main bearings, crank and crosshead brasses, and every point where lost motion could be suspected, had been keyed up until it required close watching to keep it from running hot. Still the pound kept right on in spite of everything the men could do, and to their credit it can be said that they were above the average when it came to handling a refrigerating plant.

THE TROUBLEMAN IS CALLED ON

The chief was a friend of mine, so I was asked to come over and see if I could find out what was wrong with the machine. In the meantime the men had removed the heads of the machine twice, inspected the interior, and examined every part without detecting any possible cause of the trouble. Some of the men finally thought that the pound might be due to loose springs on the suction or discharge valves, so heavier springs were tried with no better success.

I stayed around the machine for the greater part of an afternoon in trying to solve the problem. Every time I had something to offer in regard to the trouble I found that the engineers in the plant had already investigated this possibility. I was as badly stuck as the rest and finally had to leave without having solved the trouble. One thing that puzzled me was the fact that the pound happened just after the crank had passed the center—not while it was on the center. If it had been a case of too close clearance or if the piston had been striking any part of the false head, it would happen just as the crank passed the top center. As a matter of fact the crank was an inch or two past the exact dead center when the pound occurred. Also, it did not appear except when the machine was running at a fairly high speed. If it was turning 25 or 30 revolutions per minute, the pound disappeared.

The next day, when I finally found time to go over to this plant again the pound had disappeared and the machine was running like a watch. It made no difference how fast it was run, and we speeded it up to 85 revolutions per minute without a sign of a pound, it simply refused to make any further trouble. We were about as badly puzzled a crowd as ever seen.

THE NIGHT ENGINEER SOLVES THE PROBLEM

The next day the night engineer of this plant dropped in where I was working, for a short visit after he had gone off his shift. After talking over a few items in general, he finally asked my opinion about the pounding machine over at his plant, and the reason for the machine's sudden good behavior finally came out.

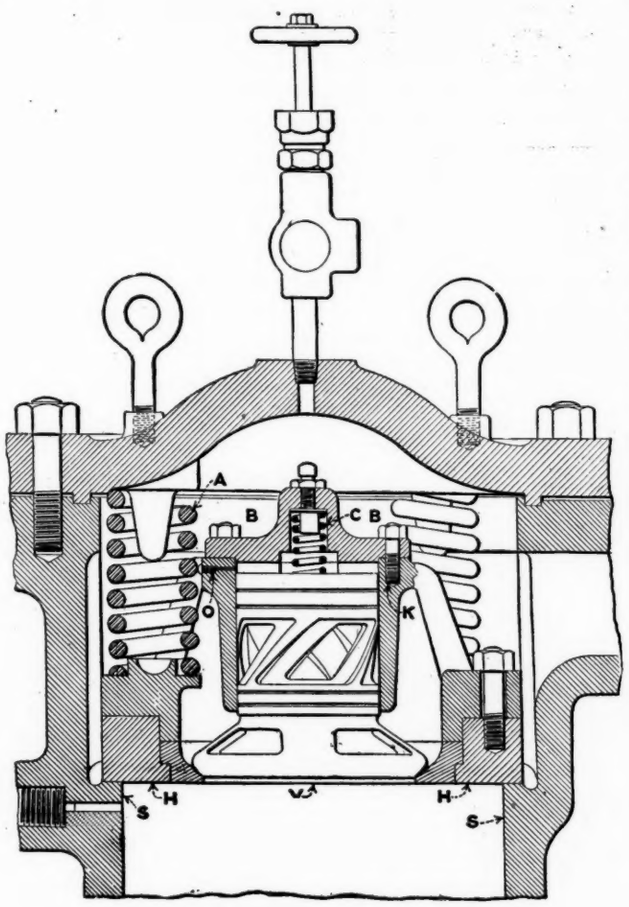
The night engineer, with the others, had been giving much serious thought to the puzzle, and on the first night after I had visited the plant he had set to work to try a wrinkle of his own for the trouble. The head was removed from the offending cylinder and washers one-half inch thick were placed on top of the springs at the point *A* indicated in Fig. 1. The head was then replaced and when the machine was again started the pound was gone.

By reference to the illustration it will be seen that the false head *H* is held down against the seat *S* on the top of the cylinder with a number of heavy springs. Sometimes these springs weaken with age and there is also in many cases a slight difference in the size of the pins or projections on the cylinder head and false head over which these springs are fitted and which hold them in place, so that if the spring has the proper tension in one place it may be too light in another place where there is more room.

This is just what happened in this case; when the machine had been opened up for overhauling, the springs

had all been thrown in a heap and of course they did not go back in the same places from which they had been taken. As a consequence some of them were too light and the false head lifted at the end of each stroke and came down with a slam just after the crank passed over the top center.

A 75-ton machine of this same type had been operating for about a year when it began to pound or slam, quite lightly at first and finally with a healthy slam



COMPRESSION VALVE DEFECT

after the trouble had been noticed for a couple of weeks. The engineer in charge was rather nervous about taking it apart and investigating its insides, so the erector was sent for from the nearest branch.

The slam seemed to take place just after the machine had passed over the top center, and after watching the machine for a few minutes he had the engineer pump it out and remove the head. When he came to investigate the valve *V*, he did not have to look for the trouble very long.

By reference to the sketch it will be seen that the valve is kept in place by a cap bolted down with bolts *BB*. These bolts had become loose, one of the nuts having worked off entirely. The spring *C* on top of the valve was now practically out of operation, and the dashpot action of the valve, which acts to cushion and dampen its movement in connection with the small hole *O* in the side of the cage, was also out of action. As a consequence the valve would pop wide open the instant the pressure in the cylinder overbalanced that on top of the discharge valve, and the only thing that prevented the valve from jumping all the way through was the fact that the valve was greater in diameter than the cage; when it hit the shoulder on the valve it could of course go no farther. After the cap had been fastened back in its proper place, there was no further trouble.

In another plant a machine of the same type had been overhauled, and when it was again put into operation and brought up to speed it produced a solid thump just after it passed the center at the top. As usual, every bearing, pin and other place that could be thought of was tightened up until they had to watch it very closely to keep from burning out the bearings.

Another Mysterious Case

Finally, I was called in to investigate the trouble. After listening to the stories of the men in charge of the plant I came to the conclusion that the trouble was inside of the machine. The men told me that they had tried changing the clearance, but this had not made any difference. They had also taken off the cylinder head, removed the false head and discharge valve, and inspected the suction valve in the piston and found everything in first-class order. It looked as if I had a pretty stiff problem ahead of me.

I went through the same performance as the men had done before me without finding anything wrong. When the machine was again started, the pound was still there. I next tried my hand at the clearance, and this failed to help matters any. Finally, after I had opened it up and put it back again three times, I decided that I would take an indicator diagram from it.

When I got my diagram, I was surprised to find that the discharge pressure at the point where the discharge should open was very much higher than the discharge pressure indicated by the gage; in fact, the discharge pressure shown by the indicator was much higher than that shown by the gage from the point where the discharge began to the end of the stroke.

After getting three diagrams in succession that were practically identical, I decided to open up the machine for the fourth time and have another look at the discharge valve. After removing the false head from the cylinder, I tried to push the discharge valve open by hand, and finally with my foot, but the best I could do in either case was to move it very slightly, barely off the seat.

I finally removed the cap from the valve cage, and when I did this I found that a small piece had cracked out at the point *K*. This had jammed between the top of the valve and the cap in the small space between the two and practically prevented the valve from moving, and consequently the false head had to lift. To remedy the trouble, we simply drilled and tapped the hole for the bolt down a little deeper and left the cracked piece out. No further trouble was experienced.

The danger which may be brought about by the use of an abnormally long spanner is exemplified by an explosion of a water-tube boiler at Glasgow, says *The Engineer*. One of the caps over a handhole in one of the headers blew off at a comparatively low pressure. It appears that the spanner supplied by the boilermakers to tighten up the caps had been lengthened by the addition of a piece of pipe to such an extent that sufficient leverage was provided to start a crack in the clamp holding the cap. This crack gradually extended, and finally the clamp failed at about half the pressure of the last hydraulic test.

Germany's Power Resources

BY "POWER'S" BERLIN CORRESPONDENT

THE Spa Treaty stipulating that Germany supply two million tons of coal monthly to Allied countries has now been in operation several months, and experience seems to prove that Germany is able to carry it out without actually stinting herself. It is an open secret that, apart from the Spa Treaty, Germany is exporting considerable quantities of coal to Switzerland and other neighboring countries. The production of coal within the German State in August was 10½ million tons, or 5½ million tons behind the monthly average of 1913.

The output of all coal mines, including the Saar district and Alsace-Lorraine, increased uniformly from 147 million tons in 1908 to 190 million in 1913, or an average of 162 million tons.

The production for the first eight months of 1920 shows an increase of over two million tons per month, from which it would appear that the supply demanded under the Spa Treaty is largely to be covered by increased production since 1919, though 1919 was hardly normal as regards coal production.

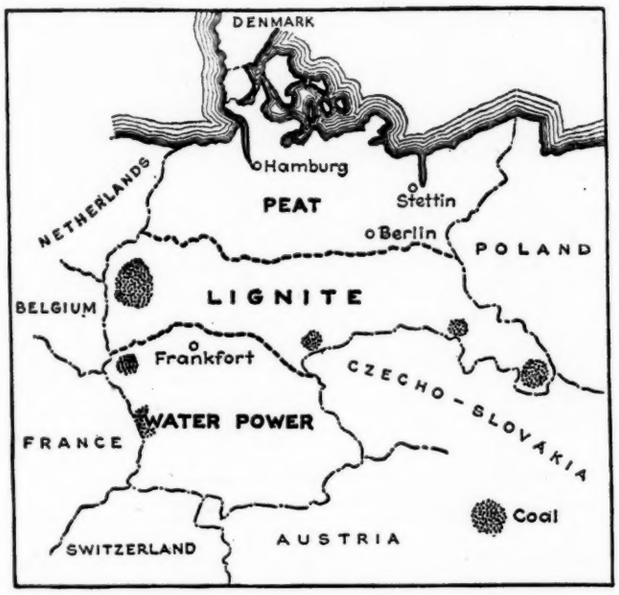
But it must be remembered that industries have improved together with railway transportation, hence more coal is needed. Therefore one can hardly understand how Germany is able, even with considerable effort, to make both ends meet or nearly so, without taking into consideration the ever-increasing production and use of auxiliary fuel like lignite and peat, with the systematic utilization of water power. The output of lignite, including briquets, has since 1908 been doubled. One large power plant alone, that of Golpa, near Bitterfield, completed in 1915, fed entirely by lignite, has a capacity of 500 million kilowatt-hours, or 6 per cent of the total electricity production of 1918.

PLANNING FOR THE FUTURE

The complaint heard now in Germany to the effect that its industry is strongly handicapped by power shortage may therefore be mainly ascribed to the forthcoming renewal of the Spa Treaty. The supplying of "reparation coal" will, however, some day stop, but Germany's industrial leaders, who are by no means short-sighted, whatever their other qualities may be, see far beyond that date and are recognizing that in the future only part of Germany's coal will be used for domestic purposes, while a large part will go out of the country, as fuel or as manufactured compounds. Coal is now Germany's gold and will remain her only specie for many decades.

Closely linked with the coal problem is that of power, although it does not appear so, because of the small percentage of coal consumed for power generation. Much attention has been devoted to the saving of coal for power production, whereas the saving in the vast remaining industrial field of coal consumption has been apparently neglected. There is, however, a system in this apparently ill-directed economy, which has a deep underlying plan. This plan, expressed in a few words, is to substitute electricity for coal in every possible way and to produce electricity with the use of as little coal as possible. This scheme is not new, but forms the nucleus of the law for the socialization of electricity, passed in December, 1919. The main object of this law is to centralize all power resources of the country for the purpose of developing an electricity supply not only for all present needs, but for all other purposes where electric power can be substituted for coal. A prominent part of this scheme is, of course, the electrification of the railways. It is further intended to develop electrometallurgical and electrochemical processes and to utilize electricity in substitution of manual power in trades, chiefly in agriculture. All the resources of the country in inorganic chemicals are to be developed, especially the large lime and alkali deposits, into fertilizers, etc. This plan will result in the concentration of power generation in a number of large central stations.

The scheme for the development of electric-power generation rests on the three power-producing agencies which Germany possesses in large quantities—water



POWER-RESOURCE MAP OF GERMANY

power, lignite and peat. As to these power resources Germany may be divided into three lateral zones: South Germany and the southern part of central Germany, where water power is in abundance; the broad belt of lignite deposits stretching from Cologne to the Lausitz in eastern Germany; and the northern part with its great marshes, where peat deposits occur in great quantities.

Some time ago the government instituted a careful investigation of all water power that is available for use economically. It appears that the practically available water power equals 10,000 million kilowatt-hours annually, or four times the energy that all public electricity works produced in 1912. Only a seventh part of this water power is used now, and the complete utilization of all undeveloped water power will, of course, necessitate building operations on an enormous scale.

Part of this building program is being carried out already, as in Bavaria; in other cases building operations are already authorized.

In the lignite zone large power plants have been built upon rich deposits in surprisingly short periods (for instance that of Golpa near Bitterfield, already mentioned, in nine months, and existing works have been adapted to lignite burning or have been increased by auxiliary lignite units, some of them of large capacity.

The distribution of electric power that is produced from lignite of course largely overlaps the lignite districts, and it is intended to stretch the radius of distribution to 150 miles. Berlin, for instance, falls easily within reach of the Bitterfield lignite deposits, being only 80 miles distant from them. The German metropolis is now to a large extent fed from Golpa, the existing local works being used for auxiliary purposes or for distribution only.

Peat an Uncertain Factor

Less favorable conditions prevail in the northern zone of Germany with regard to the use of peat. Plans in this direction are rather extensive, but it is doubtful whether they can be carried out completely, owing to the unequal quality of the peat. Complete replacement of coal in the northern districts is not seriously taken into consideration, although the advocates of the utilization of peat have estimated Germany's resources at 10,000 million tons of dried peat, capable of feeding all public electricity works as they were in 1917 for 150 years, and to run all German railroads by electric power for 220 years. There are five large peat districts in Northern Germany, and two more in the south of Bavaria. The use of peat as a fuel at first presented great difficulties, but the peat-burning electric-power plants that have been erected, of which the first was built in East Prussia in 1909 by Siemens, with a capacity of 12,000 kw., have proved quite successful. Larger works for a production of 100,000 and more are now under consideration.

Although the scheme herein outlined has been taken in hand with energy and is already in its first stages of accomplishment, the effects will not be felt for years. In the meantime another new development has been set in motion, meant to ease pressing needs of the present time, by increased production and better distribution of coal. The socializing of the coal mines, one of the urgent claims of the working classes, which has been hanging fire since the revolution, is now likely to become a fact in some shape or other. The fear is common among the large coal consumers that socialization, instead of producing an improvement, will interfere with production and make distribution even worse than it is now. As there seems to be little hope that the government will be able to improve conditions and the danger is imminent that the contrary will happen, some large power consumers have taken the matter in hand and devised a scheme of amalgamation between coal producers and power consumers. The chief aim is to put the coal consumers, mainly the large private and public electricity works and other power plants in a position to obtain their coal direct from the mines, eliminating all links between producer and consumer, especially the nuisance of government interference.

An enormous capital outlay is estimated to be necessary for increasing the capacity and efficiency of the mines. It is believed that the financial resources of the mines will be inadequate, but that large combines of producers and consumers with the common interest of large production would not only be able to supply the necessary money, but also to keep the spirit of enterprise at high tension. This is the basis of the vast scheme devised by the German coal magnate Stinnes and incorporated into his socialization proposal, which has lately produced such excited discussion in public life.

Rapid Spread of Movement for Capitalization Through Consolidation

This movement, which would lead to the formation of a number of large combines, each composed of coal consumers and coal producers, took its start with the works which Stinnes has under his own control, and has lately spread with surprising swiftness. The combine of works which are under Stinnes' control represent a trust not only of a magnitude of capital hitherto unheard of in Germany, but also of an astonishing variety.

It consists of the recently amalgamated Deutsch-Luxemburgische Bergwerks-und Hüttengesellschaft and the Gelsenkirchener Berkwerke-Aktiengesellschaft, of which a trust company has been formed under the name of Rhein-Elbe Union. The capital stock of these two companies is 26 million marks nominally, but they represent now with bonds and according to exchange quotations a capital of over one billion marks. To this trust has lately been added the Bochumer Verein für Bergbau und Gusstahlfabrikation. This combine owns a number of coal mines, steel works and machine-building shops. Another group belonging to the Stinnes trust consists of electricity works, mainly the Rhenish-Westphalian electricity works, the largest in Germany. This group owns a controlling interest in several large lignite mines. Evidencing the all-pervading influence and activity of Stinnes is the fact that he controls, besides the works mentioned, two large wood-pulp factories, the Dimes works, a motor-car factory, the Hamburger Verkehrs-Aktiengesellschaft, is the proprietor of a number of the largest hotels in the country, two or three printing works, several newspapers (among them the official organ of the German government), shipping lines and the North Sea Shipyards at Emden.

Huge Combination Developments

The latest development of this huge combine is marked by the addition of all the Siemens works, which themselves represent a combine of huge dimensions. It consists of the firm of Siemens & Halske, Berlin, Schuckert in Nüremberg, and the Schuckert Werke with all their subsidiary companies. The capital represented in these companies alone is estimated at about 1,200,000,000 marks.[1]

Of other trusts formed lately the following deserve mention: the combines formed under the leadership of Klockner, Thyesen, Haniel, Stumm and the Phœnix Aktiengesellschaft, uniting mainly coal mining, steel production, machine- and ship-building; purchase by the Hirsch interests of the Hönningen Chemical Works, the copper works of Seidel & Co., the Nüremberg cable works and the Danube Smelting Works; fusion of the Phœnix Coal and Iron Co., and Zollverein Coal Mine, with combined unworked deposits estimated at 16 billion tons.

Only a few men, rivals in industry, but having in the main points overlapping interests, are at the head of

[1] At the time this article was written, the German mark, nominally equivalent to twenty-five cents in U. S. money, was quoted in exchange at 1.4 cents.

hese huge accumulations of producers. Similar move-ments are noticeable in all the other lines of industry, and the speed by which this movement is progressing is startling. Negotiations for the formation of other trusts are going on everywhere. By the time the government is ready to make a decisive move in the matter of socialization, it will probably be forestalled by a firm phalanx of trusts, which not only will have altered the foundation upon which the socialization shall be built, but also will be so strong that the government will find itself gently pushed into the second rank.

All this is happening in a period of unparalleled business depression, which, if otherwise doing great harm, is producing at least very favorable atmosphere for the amalgamation process on the one hand, and the defeat of socialization on the other.

Lubrication of Marine Diesel Engines

BY LOUIS R. FORD

There is no other feature of Diesel-engine operation in general about which so much has been written as lubrication, but the following comment is offered as applying particularly to the lubrication of marine Diesel installations.

ON MARINE Diesel engines the general practice is to use forced lubrication for all the principal bearings and cylinders, and hand lubrication for small bearings such as valve rockers, camshaft bearings, etc. By forced lubrication is meant lubrication with oil forced into and through the bearings by means of a pump. There are a few builders who still use gravity lubrication for the bearings, the oil being fed from drip cups or wick oilers and flowing to the bearings by gravity; but the superior merit of the forced lubrication system is rapidly making it the universal standard for large seagoing vessels. Disregarding for the time being the small bearings that are oiled by hand, the lubrication is divided between two systems, the high-pressure and the low-pressure. The former includes the lubrication of working cylinders and air-compressor cylinders, while the latter includes the lubrication of main bearings, crankpin bearings, crosshead-pin bearings, crosshead guides and thrust bearing. The oil is forced into the cylinders by mechanical oilers, of which there are several makes on the market. Each consists essentially of several pumps and a reservoir grouped into a single unit, the number of pumps in each unit depending on the number of feeds desired for each cylinder. If the oil is put into the cylinder through a single hole in the cylinder wall, a condition of uneven lubrication obtains —one side of the cylinder will get all the oil and the other side will run dry. For this reason it is customary to put the oil in at two points, opposite each other on a diameter through the cylinder. Some builders put in three inlets and even four, but it has been the writer's experience that two feeds per cylinder are quite sufficient. In the case of trunk-piston engines the pistons are long enough to keep the oil inlets to the cylinder covered at all times, and as the oil enters it is spread over the surface of the liner by the movement of the piston regardless of the time in the cycle it enters. This also is true of crosshead-type engines that have a long skirt on the piston, but where there is no skirt on the piston the oil holes are uncovered on the upstroke of the piston and if oil is pumped in at this time it runs out of the cylinder without being spread over the surface of the liner. In a case of this kind the pumps must be timed so that the oil enters the cylinder when the piston is at the end of the expansion stroke. In a four-stroke-cycle engine the piston thus makes two strokes with practically no pressure and a third stroke under pressure before combustion occurs, so that the oil is spread over the surface of the liner. In the two-stroke-cycle one stroke is made before combustion occurs. The quantity of oil fed to the cylinders is best established by experience in operation. Aside from considerations of economy it is essential that the amount put into the cylinders be as small as possible because too much oil will gum the piston rings and form carbon in the slots, and

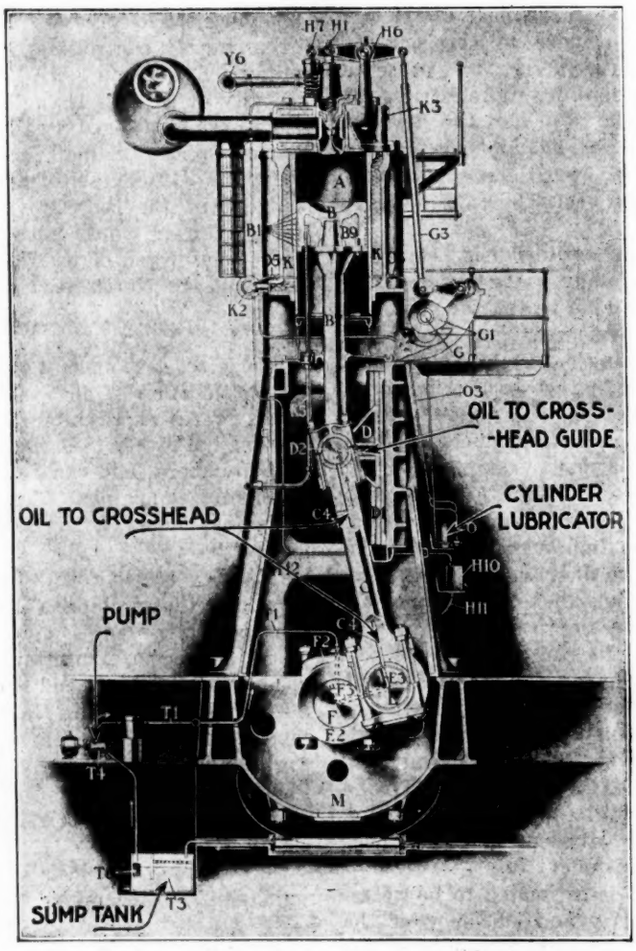


FIG. 1. LOW-PRESSURE LUBRICATION SYSTEM

in time the rings will stick in the grooves and probably break. No definite amount can be stated as correct for all engines, but a conservative figure is one gallon per 10,000 b.hp. hours and it may be found in practice that less than this will provide ample lubrication. The writer has operated successfully with one gallon per 17,000 b.hp.-hours. With the ordinary mechanical oiler a large engine will operate well with each pump feeding about 10 drops per minute, or 20 drops per minute to each cylinder. Examination of the pistons, rings and liners is the only way in which the sufficiency of cylinder lubrication can be judged. If the rings are clean and free from gum and carbon and the liners are covered with a thin film of oil, the amount of oil fed in is right, but if the rings are jammed in the slots with gummy and carbonized oil, it is a sure indication that too much oil has been used. Trunk-piston engines require very little oil pumped into the cylinders because the whole crankcase is filled with oil fog that works up into the cylinders. On the German submarine engines no mechanical cylinder lubricators are used, as it has been found that the oil fog gives ample lubrication.

Lubrication of Air-Compressor Cylinders

Great care must be exercised to keep the air-compressor cylinder oil down to a minimum. The moisture that separates out of the air in the compressor acts as a lubricant, and a very small amount of oil in the cylinders forms an emulsion that is an excellent lubricant; but if too much oil is used this emulsion assumes the form of jelly that clogs pipes, strainers and valves. With excessive lubrication in the cylinders of air compressors there is the ever-present danger of explosions in the air pipes, due to the heat igniting the oil vapor and air mixture. For the spray air compressor of the size used on the ordinary cargo ship a feed of three to four drops of oil per minute per cylinder is sufficient.

In the low-pressure system a single pump, usually gear or electric-motor driven, forces the oil through all the bearings and the same oil is used over and over. The oil enters each main bearing under pump pressure, passes into a radial hole in the crankshaft, thence through an axial hole to the crankpin. A circumferential groove in the crank boxes registers with an axial hole up through the connecting rod to the crosshead bearings, and from these bearings the oil goes through holes in the crosshead block to the crosshead slipper, from where it falls into the crankpit and drains back to the sump tank. This is shown in Fig. 1.

Clearance Between Boxes and Bearings

At each bearing a portion of the oil spreads out through the bearing and flows out of the ends, falling into the crankpit, the amount flowing out of each bearing depending on the clearance between boxes and bearing and the closeness with which the shims between upper and lower boxes hug the bearing. This is a point of considerable importance in operation. With forced lubrication the bearings can be run noiselessly with a great deal more clearance than in the case of gravity lubrication, the reason being that there is always a large volume of oil available to fill the space between the boxes and bearing and form a cushion against shock; but if this clearance is too great, so much oil will flow out of the ends of the main and crankpin bearings that the crosshead pins and guides will not get enough oil. When the bearings are adjusted, the shims should be fitted within a few thousandths of an inch of the bearing at the points *a* in Fig. 2, and cut well back between these points. This permits the oil to flow freely around the bearing, but does not allow it to flow out past the ends of the shims.

The oil flowing out of the bearings strikes the revolving and reciprocating parts and is dashed in all directions, so that the inside of the housing is filled with a heavy fog or oil spray. This makes it necessary to close the housing tightly with sheet-metal or cast-iron plates. These splash plates serve the additional purpose of preventing water, dirt or other foreign matter from falling into the crankpits and mingling with the oil. To the steam engineer, who has been used to operating reciprocating engines with all parts in sight and all bearings accessible, there comes a decided feeling of uneasiness

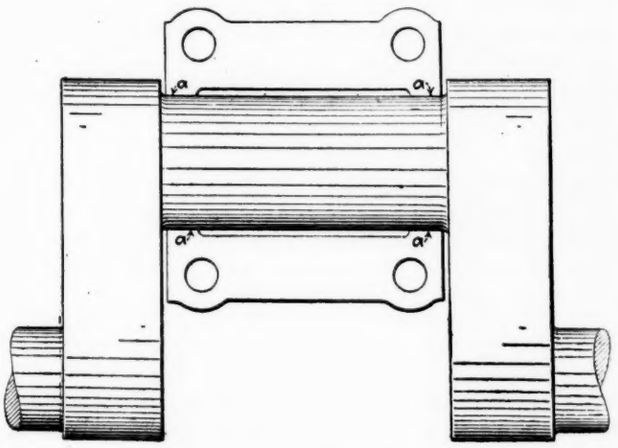


FIG. 2. SEALING MAIN BEARING

when he first becomes shipmates with the closed-in Diesel engine. In a short time he learns that with a large volume of oil being forced under pressure through the bearings, the necessity for close watch and constant feeling of the bearings does not exist, and this uneasiness gives way to a feeling of decided comfort.

Lubrication Troubles

A cooler of the tubular or coil type is usually installed in the circuit so that the oil can be cooled before it is pumped into the bearings. This cooler must be watched for leaks as a guard against water mingling with the oil. Since sea water is the cooling medium used in the cooler, a silver-nitrate test that indicates the presence of chlorine in the oil calls for a test of the cooler for tightness. If the sump tank is in the double bottom, another source of contamination is the bilge water which may leak past the sump-tank manhole gasket. If the engine is of a type that uses water for cooling the pistons, with water joints inside the housing, a careful watch must be maintained for water in the oil. Water that settles to the bottom of the sump tank can be pumped out, but if it is in suspension in the oil, it must be settled out or removed by filtering.

Effect of Water in the Oil

The difficulty experienced, due to water in the oil, is caused by the tendency of a mixture of water and lubricating oil to form a thick emulsion which clogs the oil passages. An interesting point in this connection is that oxide of iron, or ordinary rust, increases this

tendency to emulsify and increases the difficulty experienced in settling out the water. Consequently, it will be found that, if the metal surfaces inside the housing and crankcase are allowed to become rusty, enough rust will become suspended in the lubricating oil to make the water separation very difficult.

With trunk-piston engines the most serious interference with bearing lubrication is the presence of carbon in the oil due to leakage past the pistons into the crankcase. Small pieces of carbon will collect in restricted passages and stop the flow of oil, and the finely divided carbon held in suspension in the oil impairs its lubricating qualities. This suspended carbon is almost impossible to remove, and oil that has become badly contaminated in this way must be thrown away. A similar trouble is experienced with engines in which oil is used for cooling the pistons, if the cooling oil is discharged into the crankpits to mingle with the lubricating oil. Carbon will sometimes form under the top of the piston, especially if an air pocket forms in the piston, and this carbon flakes off and mingles with the oil.

Oil Heated by Hot Gases

In trunk-piston engines the oil in the crankpits receives considerable heat from the hot gases blown past the pistons and by contact with the pistons when it is splashed around the crankcase. It may be heated enough to reduce its viscosity to the point where it flows out of the bearings so rapidly as to reduce the pressure in the system below the safety point. It is this heat rather than the heat from the bearing friction that renders the oil cooler necessary. With crosshead engines having a partition between crankcase and cylinders, there is usually very little temperature rise in the lubricating oil; in fact, where the sump tank is located in the double bottom, if the ship is operating in a locality in which the sea-water temperature is quite low, trouble may be experienced due to the oil cooling to the point of sluggishness. In this case the pressure in the oil system will be above normal.

If any repair work that necessitates opening up the housings has been done in port, the strainers in the lubricating-oil lines should be cleaned shortly after getting under way. Some dirt, rags, waste, chips or filings are almost sure to get into the crankpits and will be caught in the strainers. Likewise in a new engine, no matter how carefully the parts have been cleaned, there is sure to be considerable dirt and metal dust left on surfaces that are in contact with the oil. For this reason constant filtering of the oil is advisable during the first few weeks of running. With an engine in which there is a means provided for keeping cylinder oil, carbon and water out of the crankpits, frequent filtering is not necessary after the first few weeks of running has washed all the dirt out of the engine structure, and the oil can be used indefinitely.

Precautions To Be Observed Before Starting a Voyage

It is good practice before starting a voyage to remove the splash plates, run the lubricating-oil circulating pump and observe the flow of oil from each bearing to see that it is getting an ample supply of oil. After coming to anchor or stopping for any purpose, the pump should be kept in operation until the engine cools down. This is particularly important in the case of trunk-piston engines, because there may be heat enough stored in the pistons to evaporate all the oil in the wristpin bearings if the circulation is stopped before the heat has been dissipated.

If the cylinder lubricators are located above the level of the points of entrance of the oil pipes to the cylinders, or if the oil pipes have been disconnected at the lubricators for any purpose, all the oil will flow out of the pipes when the engine is stopped. In a case of this kind the lubricator drive gear should be disconnected and the lubricators operated a few strokes by hand before getting under way, otherwise the engine will run several minutes without any oil in the cylinders.

When purchasing oil for Diesel-engine lubrication, the engineer must necessarily be guided by the knowledge gained by previous experience with oils, since he has no means for testing an unknown oil. A safe procedure is to stick to the standard brands of Diesel oil put out by the oil companies under well-known trade names. Most of these oil companies have developed these special oils by exhaustive study of the conditions met with in Diesel engines and by scientific laboratory work.

In the rare cases where bearings run hot with forced lubrication, the engineer should not make the mistake of cutting additional oil grooves in the bearing shells for the purpose of obtaining better oil distribution. This is standard practice with steam engines using gravity-feed lubrication, but with forced lubrication the heating of a bearing is generally due to insufficient running clearance or deficiency in the oil supply to that particular bearing, caused by too much oil flowing out of other bearings. If the oil gets to a bearing, the pressure in the system will cause it to spread over the bearing surface without the aid of grooves. Grooves simply make it easier for the oil to flow out of the bearing without spreading over the entire surface.

Starting a Steam Turbine

By W. Aspril

A certain gentleman of Celtic origin was once asked if he knew how to make a cannon. His reply was, "Sure! Just make a hole and then pour iron around it." It may have been a relative of his who recently answered the question, "How would you start a steam turbine?" by saying "Open the throttle and bring it up to speed." The problem is really a little more complex than this, as those who have had experience in this connection are well aware. The size of the unit is the governing factor. We know by past experience with reciprocating engines that it takes a good deal more time to bring a machine rated at 2,000 hp. up to speed than one of 200 hp., and we know, also, that a 2,000-hp. turbine *can* be brought to speed in less time than a 2,000-hp. engine, but we are equally aware that it should not be. The process of bringing a huge mass of metal from atmospheric temperature up to several hundred degrees and accomplishing its acceleration from zero to several thousand revolutions per minute is a complex one and the fundamental rule to be observed and reiterated may be formulated as "Take your time."

Importance of Continuity of Service

Operating conditions of today make it more imperative than ever before to maintain continuity of service. The increase in size of generating units has brought about a condition demanding more time for changes in station load adjustments, and therefore the

starting period bears a relation of vital importance to load variations. If load demands of a station call for a machine to be added to the line, the size of the machine must be taken into consideration and adequate time allowance made to prepare it to receive its share of the load. In modern power stations increases of loads are as a rule more or less uniform in their occurrence and so-called emergency conditions should be, and are, few in number. Hence a standard and ample time period for starting every generating unit should be decided upon and adhered to under all emergency conditions, of which a strict record should be kept with investigation and the taking of proper steps to prevent, if possible, their recurrence.

Starting Up a Turbine

Station routine covering the starting of a turbine should be very rigid, and the rules very plain and posted in such a way that the absence of a regular operator will not endanger the regular method of procedure. Before starting a large turbine from a cold condition, it should be most carefully looked over to see that no manholes are open, tools left in moving parts or bolts omitted from their proper location as the result of carelessness on the part of a repair crew.

It may be that valves have been leaking and condensation has accumulated. Test out the drains of steam header and traps. Sometimes serious water hammers and slugs arise from no other reason than the failure of a header trap to keep a line clear of condensation. If the machine has steam shaft seals, they should then be turned on and adjusted so there is not too much escaping vapor, for it should be remembered that a steam seal is functioning properly when only a small amount of vapor is showing. Circulating pump, hotwell pump and air pump should be started and vacuum "worked up." Operation of auxiliaries should be tested out, as continuity of operation of the turbine is dependent upon their working properly. The auxiliary oiling system should now be started. If sight-feed cups are provided, flow of oil should be observed at each bearing and the height of oil over pump in tank noted. It is poor "operating" to find a lack of oil in the system after the machine has been started, particularly when it has been out of service long enough to become cold.

Warming Up the Machine

For warming up the machine, the throttle should be opened until the rotor is revolving slowly, then closed or tripped. If, as in the case of some impulse turbines, the first nozzle covers only a short arc of the wheel, warming up through the throttle will produce a "hot spot" on the rotor and may result in serious distortion and consequent rubbing on stationary parts. Steam lines should be so graded and drained that there is no danger of picking up water when the throttle is open. Another simple but important item in starting up is to "listen" with a metal rod held against the shell and by so doing determining whether the rotor is rubbing or not. This is quickly done, and if omitted you can only guess as to whether the rotor is rubbing or not. As soon as the vacuum is "up," packing should be adjusted in case of steam seals, and oil flows again checked up at bearings. The throttle should now be opened just enough to keep the machine turning over at first and then gradually so that the machine is as gradually brought up to full speed.

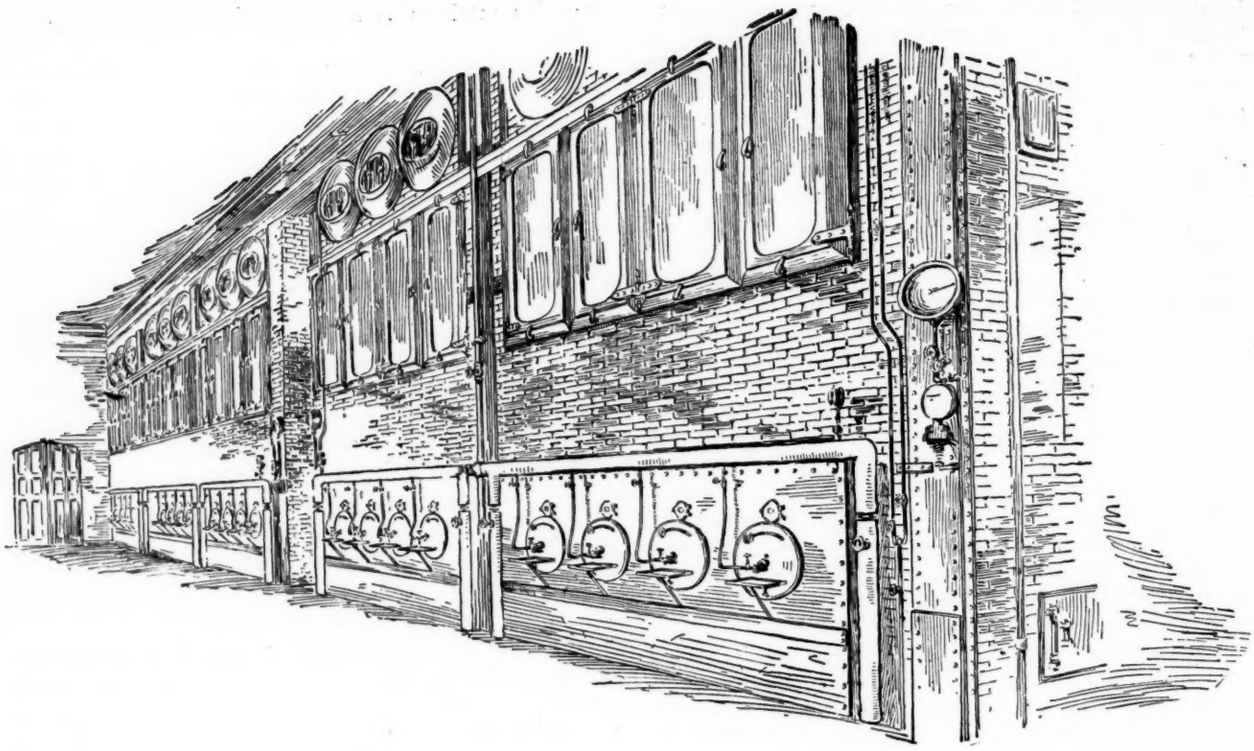
No definite time allowance can be determined upon or assigned except for each individual case, but acceleration must not be sufficiently rapid to put the machine into vibration. This is a serious condition and if allowed to continue will inevitably shorten the life of the apparatus. Very often vibration will make a reduction in speed necessary, thereby losing time "gained" by undue haste. Furthermore, vibration may result in serious internal strain and leakage of joints. Even in emergency startings, therefore, vibration must be carefully avoided. Twenty minutes or half an hour at least will be necessary, and whatever safe period for starting is decided upon for each individual machine must be rigidly adhered to. If the machine comes smoothly up to speed without vibration, you may be sure everything is as it should be, but if vibration occurs you can only surmise as to what has or has not happened. Reliability of operation under load conditions is the most important consideration and the time of coming up to speed a secondary one.

Checking Operation

After full speed is attained, it should be checked up by the indicating meter or tachometer and the normal operation of the governor observed. The operation of the oiling system should now be inspected and readings of bearing-oil temperatures taken where possible and repeated every hour, also the operation of seals observed and the condition of valve-operating mechanisms noted. In "phasing in," switchboard operators should be careful not to indulge too much in the practice of "bumping" machines. Load should be applied evenly and not in sudden jumps, as there yet remains a wide range of temperature to be passed through before reaching full load. Again, vibration must be carefully avoided; if an hour is necessary in which to apply full load, an hour must be taken. The least number of times a machine is put into vibration by load changes, the more reliable will be its operation when real emergency load conditions arise. If a machine has been shut down for a short time, the length of time necessary to bring it up to speed and put it under load is strictly a matter of judgment. For the best results the minimum time should be standardized and followed.

Turbines will operate smoothly, successfully and with less trouble to the operating force, if simple, commonsense rules are explicitly formulated and as implicitly observed. For, after all, the rules to be observed in any station are those that will promote and increase reliability of service of its apparatus. Some of the foregoing rules may seem burdensome and finicky, but when interruptions of service are properly classified and checked back with reference to their bearing on the life of the turbine, their importance can be well understood. There is too much at stake, the cost of outages is too great, to follow any other than the old rule, "It is better to be safe than sorry." Hence, and hence again, "Take Your Time."

In running air and oil lines to the engine from any distance, it is advisable to use larger pipe than the manufacturer recommends. Oil especially is difficult to handle through long lengths of small pipe. It pays to use an exhaust pit or pot outside the building walls. Fire risks are reduced and the noise somewhat lessened.



Efficient Handling of Fuel Oil—III

BY ALLEN F. BREWER

THE following general precautions should be observed: Wipe up all spilled or dripped oil promptly. Provide adequate protection in the fire room, such as a steam hose, of ample length to reach to all corners; sand boxes, of about half a barrel capacity, with scoops; and, if possible, a standard form of fire extinguisher. Test all patent fire extinguishers and try out the steam fire hose monthly. No naked light, electrical apparatus or any material that might cause a spark should be taken into any part of the boilers or fireroom, where oil vapors are likely to collect. Use only an electric lamp protected by a wire guard.

When lighting off a furnace, should the torch be extinguished or should a burner go out, the oil should be promptly turned off and the burner should not be relighted until the furnace has been thoroughly blown out with air or steam to remove properly all combustible gases. Be sure that the furnace is well ventilated and free from all such gases before lighting. Frequently ventilate all pits or inclosed spaces where oil vapor is likely to collect. Remember that oil vapor is heavier than air and tends to accumulate in low places. Should a burner become clogged with foreign matter or carbon, promptly cut it out of service and blow through with steam or air to clear all passages. If necessary, take it apart and wash with kerosene.

Always blow steam or air through a burner before lighting. If, during regular operating a burner becomes extinguished, look to one of the following causes: Water mixed with the oil, gaining entry either from the fuel tank, wet steam, or from a leaky oil heater; clogged burner due to poor filtering of the oil, or carbonization at the tip on account of excessive preheating of the oil; too much excess air, or air passing over through the oil lines.

In cutting out a burner, first shut off the oil valve and allow the oil remaining in the burner to be burned out; then shut the steam or air valve. Never omit blowing a burner through with steam or air for about half a minute after use; this will insure cleanliness. Explosion or flareback of a boiler furnace is generally due to attempting to light a burner from the red-hot wall; to an excessive accumulation of combustible gases caused by not closing the valve; to a burner that has gone out; to leaky burner connections, or to insufficient ventilation of the furnace prior to lighting off. The remedy is to close instantly the master valve on the oil line and speed up the blower,

Having dealt with the principles of operation of oil burners in the first article of this series and with the indications of efficient operation in the second one, the general precautions to be observed are taken up in this article, which include the care of the burners, the cause of explosions and flarebacks, proper atomization, temperature and pressure of the oil and other details of which the operator should know.

if one is installed, or open the dampers wide. Frequently inspect for leaks in obscure parts of the oil line. Oil leaks are dangerous at any time and should be repaired immediately. Continued leakage is sure to create a certain amount of inflammable gas, and danger of explosion in case of sparks thereabouts will always be imminent. Leaks at the joints are most prevalent. In repairing such it is generally preferred, with flanged fittings, to make up with a metal to metal surface. In the event that such does not prove tight, the use of a cardboard gasket soaked in oil, or a litharge-glycerin paste, is effective. When making up screw connections the latter paste will generally keep the joint tight, if red or white lead has been tried and found faulty.

Burners should be free from oil leaks at all joints. To best test for leaks, connect the oil passage of the burner to a high-pressure water hose, using a pressure equal to the normal oil pressure carried. Defects in the joints or an uneven spray can thus be easily detected. If a burner is cut out for any length of time, frequently inspect the oil valve to see that no oil is leaking past into the burner and furnace. If flames appear at the stack, cut down on the oil and speed up the air travel through the furnace as much as possible.

Proper Atomization

The extent to which proper atomization will occur, will depend largely on the gravity of the oil and the pressure under which it is fed to the burner. A heavy oil will require a higher pressure than a light oil to break it up into as fine a spray as possible and to prevent fluctuation in flow. The extent to which pressure must be regulated can be gained only from experience and close observation of the spray. In general, using a steam or air atomizing burner the pressure should range between 30 and 50 lb., if an air chamber is on the oil line. In the absence of such, however, it may be found advisable to increase the pumping pressure above 100 lb. to cut down the effects of pulsation. With a mechanical burner in general, a pressure between 100 and 150 lb. will suffice.

Procure dry steam if possible for use in a steam atomizing burner. The presence of water in the steam will cause the flame to sputter, retard combustion and may even put out the burner. A steam trap is a valuable adjunct to install on a burner line.

Never forget to cut out the atomizing steam or air when the oil has been turned off. Should the burner be cut out for any length of time, it is well to leave the steam or air valve cracked to permit of a slight passage of either steam or air and thereby keep the burner cool enough to prevent damage from the furnace heat.

Excessive heating of the fireroom from the burners may be somewhat prevented by fitting a shield over the firing door, with peep holes to correspond to the hole in the furnace front, and so hinged as to permit of its being opened for the adjustment of the oil, steam or air valves or register vanes (in a mechanical burner system). In a mechanical system no air should enter the furnace except through the air vanes and register at the burner itself. Air leaks in the setting should be promptly calked.

One of the most detrimental features likely to occur in a mechanical system is vibration of the boiler. This is usually due to pulsation in the oil line, air delivered at low velocity or a slug of water carried over by the oil momentarily cutting out the flame, the re-light occurring with a vibrating shock, dependent in its intensity on the amount of vapor in the furnace. To best counteract this condition, cut out the burner or burners until the blower is speeded up.

When operating a mechanical oil-burning system, the temperature and pressure of the oil should be maintained as nearly constant as possible, varying the air supply and number of burners in accordance with the demand for steam.

In a mechanical system, the air pressure should always be available equal to that required when all burners are in use; so that when operating with any burners cut out, if the load demands, they can be cut in and promptly receive the proper amount of air. Speed up the blower when cutting in additional burners and slow it down when cutting out burners, so as to maintain proper air conditions.

Pumping, Straining and Draft

When a standpipe is installed between the oil pump and the burner line for maintaining a steady, uniform pressure on the oil to the burners, means should always be used to prevent the danger of flooding the furnaces when the burners are not in use, should a valve leak or be left open by accident. If no mechanical safety device is installed, double master valves should be put in on the main oil line to the burners and frequently inspected.

Oil strainers are an important item in the fireroom equipment. They should be examined twice a day in general, and cleaned if necessary. The frequency of such, however, should depend on experience and the grade of oil used. Never raise the oil pressure instead of cleaning the strainers. This will result in dirt being forced through the strainer and into the burners and may cause clogging of the latter.

With either a steam or air type of burner the draft is best regulated by means of the damper, keeping the ashpit doors at a constant setting; this may be wide open in some cases, but experience and practice must be used in determining their best position. There is, thus, a very slight draft prevailing within the boiler setting and air leakage through the latter is reduced to a minimum. Furthermore, the flow of gases will not be affected by undue air currents, but will tend to travel by their own momentum to all parts of the furnace setting and heating surfaces.

Under reduced load it may be necessary to slightly regulate the ashpit doors to prevent a positive pressure and a consequent blowing of the gases out into the fireroom.

Should the boiler pressure drop, when the stack is clear and the oil flow seems right, cut down on the rate of air passage by closing the damper somewhat; or, in a mechanical atomizing system close in on the air regulators.

Soot blowers are a valuable equipment if properly used. The frequency of blowing soot should be determined by experience and trial. On an average once every eight hours will be enough.

Watch the water glass carefully and frequently. It is well to remember that when using fuel oil the danger from low water may be far more severe and imminent than when using coal, due to the higher furnace temperatures and greater speed in fluctuation. A safe rule is to cut out the burners promptly in case of low water.

Electrode Holders for Metallic Arc Welding

Essential Requisites of Electrode Holders—Principal Defects To Be Avoided —Importance of Using Good Materials and Rational Design, Regardless of Cost—Typical Design Suggested

BY L. W. WEBB
Master Electrician, United States Navy Yard, Norfolk, Va.

AS THERE has been a great variety of electrode holders furnished by the various manufacturers with their apparatus, it might be well to consider the good and the bad features of electrode holders in general, so that, in making a selection of the type to be used, proper care can be exercised to insure obtaining only those that will prove satisfactory to operators in general. Some of the essential points of efficient electrode holders are as follows: (1) Lightness; (2) secure grip on electrode; (3) ease in changing electrodes; (4) protection of operator against electrical shock; (5) electrical connection to holder and flexibility of lead; (6) first cost; (7) general.

1. Since the fatigue of the operator reflects directly in a decreased output, it is most important that electrode holders be made as light as possible; for, even under the most favorable conditions of horizontal welding, the operator's arm is in such a position as to be easily fatigued, while in vertical or overhead welding, the tendency to fatigue is greatly increased. The greater the weight held in the hand under such conditions, the sooner the arm becomes fatigued and must be rested. Lightness therefore is very desirable, and in the design of holders every effort should be made to obtain lightness without sacrificing mechanical strength or current-carrying capacity.

2. Unless the holder grips the electrode securely to prevent it from slipping or twisting, much time may be lost by the operator in starting and maintaining the arc. This also tends to distract his attention from the work itself and irritates him, resulting in decreased output.

3. When it requires any special time to replace electrodes with new ones when the previous ones have been used up, the type of holder cannot be classed as efficient. The change should be easy in a poor light, and no feeling around to insert the wire in a hole or any similar nice adjustment should be necessary. Some form of jaw clamp is preferable, which can be opened to allow the stub to be dropped out and a new piece inserted mechanically by mere sense of feeling. The jaw clamp should be so designed as to be easily opened by pressure of the thumb on a lever attached to the handle of the electrode holder and to close automatically and clamp the electrode by some form of spring when the thumb pressure is removed from the lever.

4. The handle should be insulated to protect the operator from any chance of receiving electric shocks, especially when welding is done with open-circuit voltages in excess of 60 or 70 volts; for when an operator has received a shock sufficient to even partly unnerve him, he becomes nervous, and decreased output follows. When working in certain close places, the operator's whole body and clothing become saturated with moisture from perspiration, and under these conditions it is very easy for him to receive an electric shock when changing electrodes (especially when he is not provided with and required to wear a good grade of non-absorbent gloves on each hand). These gloves should have gauntlets extending well up on the arm, with a strap at the top to prevent sparks and hot metal from getting between the glove and the arm, or special arm protectors to fit over the top of the glove. The gloves also obviate the use of the shield often placed on many types of electrode holders to prevent falling sparks or hot metal from reaching the operator's hands or arms, and the saving in weight is to be considered.

5. The electrical connection to the holder should be the best obtainable and thus do away with any chance of loose connections which might generate heat and cause discomfort to the operator while welding. These connections should be made of extra flexible wire and be about ten feet long, with means provided for attaching to the main welding leads, either by bolting lugs together or by plug and receptacle connections. This wire gives an operating range of approximately twenty feet from where connection is made to the main welding lead. The wire need have no special insulation, and usually a circular loom type of woven braid is the most satisfactory one. The lighter this cable is made for the current to be used the more satisfactory it is, as the operator has less weight to carry with the holder.

Welding currents that are as high as 175 to 200 amperes can be safely handled by a cable made up of 703 copper wires, No. 29 B. & S. gage, in 37 strands of 19 wires per strand, with a cover of high-grade cotton yarn woven on a circular loom principle; while currents as high as 80 to 100 amperes can be handled safely by a cable made up of 361 copper wires, No. 30 B. & S. gage, in 19 strands of 19 wires per strand, with a woven cover similar to the foregoing. Both of these cables are extremely flexible, light, and mechanically stronger than more flexible cables of the same cross-section, but with more strands of a smaller-sized wire, and are believed to be entirely satisfactory in all respects.

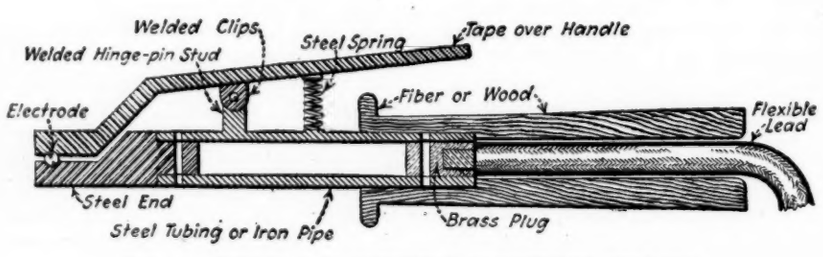


FIG. 1. DESIGN FOR WELDING ELECTRODE HOLDER

6. Often in purchasing electrode holders, the first cost is considered above all things, while in reality this should not be

considered at all. The most elaborate holders are necessarily the most expensive ones, and the cheapest ones usually have many defects and are made of poor material. The middle course is apparently to select one that is made of the best material and possesses all the qualities of lightness, secure grip on electrode, ease in changing electrodes, etc., as mentioned and at the same time is not so expensive that it cannot be readily discarded when it becomes burnt so as to lose these qualities. It can readily be seen that even a total of ten to fifteen minutes lost each day by an operator using a defective electrode holder would in the course of a year more than pay the cost of six to ten new holders at from $8 to $5 each, considering only his wages, and not the loss incurred through decreased production, which usually amounts to many times more than the operator's pay.

7. General: The sketch shows a simple form of electrode holder that meets all the requirements enumerated and that is easy to make and costs little. A piece of ½-in. steel tubing or iron pipe is used as the body of the holder with both ends reamed out to receive at one end in a tight fit the lower jaw of the electrode grip, and at the other end a brass lug for the flexible lead. These are preferably pinned and riveted to insure better contact. The steel end can be made from round stock with part milled or sawed out, and the electrode grip can be tempered or casehardened, depending on the material it is made of. The upper jaw of the grip and the handle can be either forged or cut from steel plate.

The hinge clip can be bent up from straight plate and welded to the upper jaw of the grip, as shown. The handle and shield can be made of fiber or hardwood which does not easily split. It can be readily seen that materials to make these electrode holders can be found in any shop, usually in the scrap pile, where miscellaneous small ends, etc., are salvaged, and the material cost is therefore practically negligible. The cost of manufacturing one of these holders, exclusive of the flexible lead, should be less than five dollars.

Properties of Steel

By Daniel R. Long

The general adoption of the Boiler Code of the American Society of Mechanical Engineers as a standard for the construction of boilers has brought specifications for boiler steel to the attention of engineers, boiler makers and inspectors. Almost everyone interested has read Part I of the Code, and some have asked why the specifications for steel therein contained limit various ingredients such as sulphur and phosphorus. The purpose of this article is to describe briefly the methods of steel manufacture and to answer some of the questions commonly asked in regard to properties of steel.

No Generally Accepted Definition for Steel

There is no generally accepted definition for "steel" because it is a hard matter to get one definition that covers the wide range of steels manufactured at the present time. Generally speaking, steel is an alloy of iron produced by the complete fusion of materials in a bath. The properties of steel depend on the method of manufacture and the proportion of carbon and other ingredients it may contain. The proportion of carbon ranges from 0.1 per cent in firebox steel to 1.2 per cent in some tool steel. It will be seen that in carbon content steel is intermediate between wrought iron and cast iron. It follows, therefore, that steel may be made either by increasing the carbon in wrought iron or decreasing the carbon in cast iron. Crucible steel is made by the first process, and open-hearth and bessemer steels are made by the second process.

The Open-Hearth Process

In the open-hearth process pig iron, wrought iron, steel scrap, and sometimes other metals or ores, when special steel is desired, are melted on the hearth of a rectangular reverberatory furnace heated by gas on what is known as the regenerative system. With this type of furnace, temperatures so high that they are limited only by the ability of the refractory linings to withstand the heat are possible. These high temperatures cause the oxidation, or "burning out," of the carbon in the charge. When the proportion of carbon has been brought down to the desired point, a charge of spiegeleisen or ferromanganese is added. The manganese acts on any iron-oxide slag remaining in the bath, separating the iron from the oxide and returning it to the bath, while the carbon unites with that already present, producing steel with the desired proportions. The iron oxide must be removed because if it is allowed to form a part of the charge, it causes the steel to be red-short.

Open-hearth steel is made either by the basic or by the acid process. These processes differ in the slag carried and the materials used in the construction of the hearth. With the basic process it is possible to use raw materials having a comparatively high percentage of sulphur and phosphorus. Basic material, usually calcinated lime, is added to produce a slag that will eliminate the impurities. The only difference in the furnaces is in the material used in the linings and hearth. In the basic process the linings are made of gannister or calcined magnesium limestone so that a basic slag may be carried; in the acid process the furnace linings are made of silica sand or firebrick free from excessive amounts of iron oxide. It must be remembered that the hearth itself is inert and takes no part in the reactions in the furnace, but must be constructed of materials corresponding to the slag carried, because the slag is the active agent in producing the purification of the charge and if the furnace linings and hearth do not correspond they will be rapidly destroyed.

The acid process was the first open-hearth process used and was thought superior for a considerable time after the basic process had been introduced. The superiority of acid open-hearth steel was thought to be due to the fact that purer materials must be used in this process, but the present methods of handling the basic process make it possible to produce steel just as pure and reliable as was ever possible by the acid process.

Bessemer Process of Steel Making

In the bessemer process molten cast iron is placed in a vessel known as a converter. The carbon and silicon are burned out by forcing a blast of air through the molten iron. Spiegeleisen or iron containing considerable carbon and manganese is added in such amounts as are required to make the charge satisfactory. As with the open-hearth process the bessemer process may

be either acid or basic. With the acid process the lining of the converter is made of silica sand or firebrick containing little iron oxide. In this process practically no sulphur or phosphorus is removed. This makes it necessary to use iron that is very pure at the beginning of the process. In the basic process calcined lime is added just before the charge is poured. This causes the phosphorus to leave the steel and enter the slag. On account of the basic nature of the slag it is necessary to have the lining of the converter made of gannister or calcined magnesia limestone. The removal of phosphorus possible with the basic process makes it possible to use an inferior grade of cast iron.

The Bessemer and Open-Hearth Processes Compared

Bessemer steel is not suitable for the construction of steam boilers or pressure vessels. Boiler plate and boiler tubes should be of open-hearth steel for the following reasons:

1. It is possible to test and control the ingredients in open-hearth steel during the process of manufacture. This is not true of bessemer steel.
2. Open-hearth steel is more reliable and less likely to fail in an unexplainable manner. Past experience has proved bessemer steel unreliable in many instances.
3. On account of the thorough mixing of the charge in process of manufacture, open-hearth steel is more homogeneous in composition and uniform in physical properties than bessemer steel.

Crucible Process of Making Steel

In the open-hearth and bessemer processes it is necessary to reduce the carbon originally in the cast iron; in the crucible process it is necessary to increase the carbon in fairly pure wrought iron. Wrought iron, puddled iron and scrap steel having a very low carbon content are melted in small crucibles with enough charcoal to give the required amount of carbon. Ferromanganese or oxide of manganese and other ingredients are sometimes added. The crucible process is used only to produce very fine tool steels in which the cost is of secondary consideration.

Effects of Various Ingredients

The process of manufacture usually removes nearly all silicon from steel; in fact, steel used for boiler plate and structural work is practically free from this ingredient, there being not more than from 0.025 to 0.05 of 1 per cent present in these grades of steel. It is a valuable agent in preventing "red-shortness" by eliminating oxides, but on the other hand, when present in any quantities after the oxides have been eliminated it will cause red-shortness. In fact, all alloy steels containing considerable quantities of silicon must be worked at low heats.

Oxides are usually present in soft steels and steel low in manganese. They produce red-shortness.

Phosphorus causes cold-shortness in steel. In fact, a high-phosphorus steel is very unreliable and uncertain at ordinary temperatures. The grain of steel having a high phosphorus content is coarse, and the point to which the steel may be heated without injurious effects is reduced by the presence of the phosphorus. On account of these defects phosphorus is considered a dangerous impurity in steel and the amount permitted in boiler and structural steel should be carefully regulated by rigidly enforced specifications.

Steel having a high sulphur content is bound to be red-short. Most high-sulphur steel will be thrown out of the rolling mill because of cracking. The cold properties of the steel are not materially affected by the presence of sulphur with the exception of a slight increase in tensile strength, but the welding and forging properties are reduced and a red-short steel is, of course, very undesirable for boiler work. Sulphur is an impurity that is difficult to remove. Metallurgists have controlled all the other impurities and in fact have devised reactions that cause the impurities to do useful work during the process of manufacture, but sulphur is hard to control and difficult to remove. For this reason it is frequently present in injurious amounts in boiler steel, and as with phosphorus it is important that rigid specifications be strictly enforced.

Manganese increases the "hot ductility" of steel, thereby improving the rolling and hot working qualities and is an antidote of red-shortness. It removes sulphur and iron oxide during the process of manufacture and counteracts the effects of such amounts of sulphur and phosphorus that may remain in the steel. The presence of sulphur and phosphorus tends to make a coarse-grained steel, but the introduction of manganese prevents this and produces a fine-grained structure.

Steel low in manganese will crack along the edges during rolling or forging operations, while the same steel will work satisfactorily if the manganese content is increased. Boiler steel should contain not less than 0.3 per cent manganese. Flange steel may contain not more than 0.6 per cent and firebox steel not more than 0.5 per cent manganese.

The amount of carbon in steel will determine its most important properties. Boiler and structural steel should contain not less than 0.12 per cent nor more than 0.25 to 0.30 per cent. Carbon increases the strength of steel up to 0.9 per cent, but above this amount the strength diminishes. Increasing the carbon will also decrease the ductility and elasticity.

How Semi-Steel Is Made

A metal bearing the trade name of "semi-steel" has been introduced during the last ten years. It is made by melting together about 30 per cent of mild-steel scrap and 70 per cent of pig iron. Manganese or other special fluxes are introduced in small amounts to improve the strength, toughness and machining qualities and to counteract the presence of impurities. A metal having a tensile strength of 35,000 lb. per sq.in. is produced by this process, but this may be considered only as a good grade of cast iron and for that reason should not be used in connection with boiler work where the use of cast iron is prohibited.

The electric industry of Japan, says the *Asahi*, is principally run by means of water power, and the employment of this power will grow. The water power available is considerable, but the methods now adopted by private companies are imperfect and extravagant for the most part. Furthermore, there is such keen competition among the applicants for water-power rights that they are often secured merely for speculative purposes and without any intention of using them. Of the estimated unused water-power capacity, more than 3,000,000 horsepower has already been granted to private concerns, but it is doubtful if the holders of these rights will start work within the next ten years.

EDITORIALS

Standard Specifications Adopted

THE Government is again advancing the cause of specifications for liquid fuels and lubricants in the continuation of the work of the Committee on Standardization of Petroleum Specifications, which has just reported. These specifications are a revision of the requirements that have been in force for some time covering all Government purchases of liquid fuels, lubricants and other petroleum products.

There is an increasing tendency on the part of the states to make compulsory for all petroleum products compliance with specifications such as these. In fact, a number of states have adopted the proposals of this Government committee with respect to gasoline, and it is likely more will take this action as time goes on and the value of reliable specifications and methods of testing is appreciated. The users of petroleum products can well co-operate in this movement by the adoption of this type of requirement for their purchases as well.

The Federal officers who have drafted these specifications have very materially improved them by inclusion of clear and significant methods of testing for determination of compliance with the standards set. It is of little use to specify viscosity, flash point, distillation test or other characteristics without making clear what is to be the laboratory procedure for determination of acceptance or rejection. It is very fortunate that this feature has been so clearly recognized and so amply cared for by the new regulations, which are Bulletin No. 5 of the committee. Those who have to do with the production, the marketing, the purchase or the use of petroleum products in any form will do well to secure and study this bulletin. It can be obtained from the petroleum division of the Bureau of Mines on request. There is no excuse for not getting it and still less excuse for not using its valuable recommendations.

In the Light of History

POWER-PLANT engineering has behind it a wealth of history and tradition. The development from the efforts of the Marquis of Worcester, the achievements of Savery and Newcomen, the fruition by Watt, the improvement by Corliss and others, the invention of the steam turbine, and the internal-combustion engine, is full of human as well as engineering interest.

Side by side with this story of mechanical development goes one of the development of the science, of the practical application of which it is the art. It is not so many years ago that heat was considered as a substance called "calone" which was absorbed by bodies as is water by a sponge and squeezed out by friction, percussion and compression. The whole history of the science of thermodynamics is compassed by the appointed life of man.

No man can have an adequate conception of the present state of an art without knowing its history and traditions. There is no better incentive to the imagination and vision which points out the possible and leads to achievements than a knowledge of the past. Any man who knows the history of steam engineering is a better engineer for knowing it, and the day's work takes on a new aspect seen against such a background.

We suggest to educational committees and those having the preparations of meetings in hand, that an occasional different but attractive and profitable program can be made by seizing upon the birthday of one of those who have worked or written themselves into this histry and making him the subject of the nearest meeting to that date. Learn where he found the engine and what he did to it, where he found the science and what he added to it. Learn to know Watt and Corliss in their working clothes and not when they were sitting for their pictures.

There are those who will decry spending time upon a "bunch of dead ones." They want to live in the present, to learn something new, to reach out into the future. And if they can learn but one thing or one class of things, they are right. One may bury himself in the past, but in the right kind of a mind the present and the possible will be more intelligible and loom larger in the light thrown upon it by a knowledge of the past. It is difficult to extend a curve into the unknown, startin from a point, but if the direction and tendency which it has been following are known, it is comparatively simple to forecast its course, at least for a little way.

Continue the Thrift Habit

THE week just passed has witnessed a nation-wide thrift campaign in which schools, churches, labor and business organizations, the press and Governmental agencies have all taken an active part.

Americans as a class are notoriously thriftless; they respond readily to intelligent appeal, but are prone to forget easily. The results of this most recent campaign will be hard to measure, but it has undoubtedly started thousands to thinking and acting along the lines of thrift. However, let its effects not be like the old-fashioned church revival that got all the sinners and many more imaginary sinners in a repentant mood only until, after a good sleep, another day found them again following along the old paths. The thrift movement must not be allowed to lapse with the close of the present campaign; it is too necessary to general prosperity; its spirit should be carried forth through every day of the year until the American becomes a close second to the Scotchman.

The present is a most opportune time to invest. No longer is it easy to finance through the usual channels, as these reservoirs of capital are to a large extent temporarily tied up. Therefore, industry must turn to the small investor, a class to which many engineers belong. Good securities can be had at favorable figures. Money must be coaxed from the proverbial stockings, and the workingman must be encouraged to put aside part of his wages into savings. There are many co-operative plans for saving, some better than others but all striving toward the same end. When it is realized that five

dollars invested weekly at six per cent interest will amount to five thousand dollars in approximately thirteen years, or if continued for twenty-five years will reach nearly fifteen thousand, the benefits are at once apparent.

It has been claimed that during a period of business depression people should be urged to buy. This, however, is not inconsistent with advice to save. The point is that people should be urged to buy wisely. As one student of economics fittingly expressed it, it is better to pay a dollar for a shovel and put it into the hands of a workman than to pay the same amount for a box of candy and put it into his stomach. In both cases the dollar has given employment to labor and contributed to a business enterprise. The candy, however, stops at that, whereas the shovel goes further—it is a tool that will enable the workman to produce more and therefore represents a productive investment. Bearing this in mind, the small investor will be helping both himself and industry as a whole if he will select investments that are productive.

Natural Gas and Power

THE natural-gas situation is very much in the public eye just at present in Pennsylvania, Ohio and West Virginia, and numerous conferences have been held by the members of the public service commissions of the three states with both producers and consumers of gas. Looked at from a distance, the problem is not simple. That the natural-gas supplies of the states mentioned have passed their maxima and begun to fail, is asserted by the state geologists of the three states and by many other impartial investigators.

State Geologist George H. Ashley of Pennsylvania has expressed the belief that, while urging the utmost care in the production and use of gas, the first logical step is a classification of the uses of natural gas into what may be called necessity uses and luxury uses. Some household uses are luxury uses and some industrial uses are necessity uses. A campaign, therefore, to cut off indiscriminately all industrial users, such as is being urged, would work great hardship on many industrial concerns.

In general, necessity uses may be defined as those requiring an intermittent supply of heat or power, or those in which the "stand-by" losses of a coal fire make up a large percentage of the heat used; or uses for which artificial gas would commonly be substituted if natural gas were not available, and certain industrial uses for which coal cannot be used because of the contained sulphur or because the heat of the coal cannot be advantageously applied. Other uses, such as household heating, steam raising or other power uses, will obviously fall in the class of luxury uses.

At present there is a strong and growing demand that the industrial use of gas be stopped entirely in order that the gas may be conserved to meet household demands. The indiscriminate cutting off of industrial concerns will work a hardship on many companies and will also work a hardship on household consumers who use the gas for cooking and water heating, because of the necessity of passing on to them the additional cost of the large plant necessary to meet the high peak load of winter. It would, therefore, seem more reasonable that careful study should first be made of the uses of gas in order to determine which ones should be permanently cut off, and this evidently would involve stopping the use of gas under power boilers and many other industrial operations and would also eliminate its use for house heating. At the present time the amount of gas used under boilers for power is not large. Figures are available for 1919 covering the use of gas for the production of electric power. In that year, according to the estimates of the United States Geological Survey, 271 million cubic feet of natural gas were used in Ohio for electric power alone, 96 million cubic feet in West Virginia and 53 million cubic feet in Pennsylvania. Assuming that this was not burned in internal-combustion engines, it makes a total of about the equivalent of a little over two hundred thousand tons of coal—not a large amount. Obviously, a large part of the gas used by industrial concerns in the past has not been for the production of power, but in metallurgical processes and in the making of glass and in similar operations.

The shutting off of the supplies for heating and power introduces new problems. It means, first, an added burden to our coal production; but more than that, it will mean to a large number of people a retrograde movement from a source of heat that can be handled with a minimum of trouble back to the coal shovel.

It is time for sound thinking on this matter and the laying aside of personal interests. If natural gas continues to be used indiscriminately, as at present, the supply will be exhausted in a few years and all interests will have to look to some other source of fuel; whereas, if its use is limited to purposes in which gas is an essential, the exhaustion of the supply will be deferred for a generation or two with a resulting benefit to all.

The Fallen (?) Foe

AS A NATION we are properly prone to look kindly upon the under dog, and have been undergoing a period of reaction from the righteous hates of war to a feeling of benevolent tolerance for a (theoretically at least) vanquished adversary. Hence more or less maudlin sympathy for the oppressed debtor struggling under the onerous demands of the victorious and presumably Shylockian allies.

There is, however, abundant food for thought in two headlines appearing in a recent issue of a New York morning paper reading "Germany Refuses to Disarm," and "Growth of Trusts in Germany." The fact is, that with "kultur" relegated for the time being to a back seat, "preparedness" is, from a financial viewpoint and as applied to manufacturing interests, assuming a magnitude worthy of no little careful attention and study.

Trusts, intertrusts and super-trusts are being fabricated, interlocked and cemented into a gigantic structure destined to become a logical and overtopping successor to the system of inter-related financial activities which, with the fundamental support of the Deutsche Bank, was aiming at world-wide commercial control when over-confidence precipitated the greatest international struggle of history.

The article on "Germany's Power Resources" in this issue gives a clear idea of one of the biggest elements entering into the reconstruction problem, an element which in itself, and unless nullified by political conditions, internal or external, should effectively set at rest any doubt or worry as to the ability of Germany to meet its obligations, always provided it has the honest intention, or even desire, to do so.

CORRESPONDENCE

Saved Four Tons of Coal Per Day

It seems to be the opinion of the average plant manager or superintendent that the waste in boilers and furnaces cannot be stopped without equipment changes that would cost more than the saving made.

The manager of a plant of 600 boiler-horsepower knew that there was a waste of fuel, and he had heard of 20 or 25 per cent being saved in other plants, but he had never seen it done. On being referred to a large plant that had made a saving of 28 per cent in fuel consumption, he consented to have his plant inspected and see what could be done, with the understanding that the equipment should not be changed and that it would not cost over $300 to make a saving of fuel. The plant has two 300-hp. horizontal water-tube boilers with chain-grate stokers.

It was found that the boilers, settings and furnaces were in very good shape. Thirty-six tons of coal was put through the furnaces in 24 hours with the boilers working at 50 per cent efficiency. The coal is anything from culm to run-of-mine and has a calorific value of from 9,000 to 14,000 B.t.u., and with 6 to 20 per cent ash, the samples being taken from different parts of the storage pile and from two cars that had just been received. The evaporation was from 5 to 6 lb. of water per pound of coal with a feed-water temperature ranging from 120 to 160 deg. F. The flue-gas analysis showed an average of 6 per cent CO_2. With a flue-gas temperature of 600 to 700 degrees.

When the coal was unloaded at the plant from the cars, the culm and slack was placed in a separate pile. When it was necessary to elevate coal to the storage, over the boilers, it was loaded in cars and put through a crusher, first a car of culm or slack and then a car of run-of-mine and so on. Therefore, the coal came to the furnaces either all culm or slack or partly mixed with lumps as large as broken coal, and the fuel bed would become so thick that the proper amount of air could not pass through it or it would be so uneven that it was from 5 to 8 in. thick at some places and at other places there would be no coal at all, or else it would be covered with ash and clinkers. The pressure carried was supposed to be 150 lb. gage, but the steam chart showed a range of from 120 to 150 lb. with a steady load on the boilers.

By putting a partition in the overhead storage bunker and arranging a chute so as to direct the culm and slack coal to one side and the larger coal to the other, each furnace was given a more even-size run of coal, and the fires were kept at an even thickness on all parts of the grate and a steady steam pressure was maintained.

Flue gases from the furnace burning the culm and slack showed an average of 12.2 per cent CO_2 with a stack temperature of 490 deg. F. The other furnace gases showed an average of 13.6 per cent CO_2 with a stack temperature of 520 deg. F. The evaporation on the first boiler was 7 lb. of water per pound of coal, with a feed-water temperature of 120 to 160 deg. F., and the other was 9.2 pounds.

Steam in this plant is used for drying purposes in kilns and in vats for boiling the raw products. There is about 10 per cent makeup water used for boiler feed. The returns are sent back to a receiving tank by two traps at a temperature of 230 deg. F. and cooled by a cold-water spray so that the pump can handle it. This tank was four feet below the suction line of the pump, but after placing it on the floor above, which is ten feet higher, the pump was able to deliver the water to the boilers at a temperature of 214 deg. F. After making these changes, a test was made. The boiler that had the culm and slack coal showed an efficiency of 54 per cent and the other 64 per cent.

The material and labor cost of making these changes was $192, and the saving is 4 tons of coal in 24 hours. As the company paid from $9.75 to $12.30 per ton for coal, the saving per month amounted to about $1,440, or enough to pay the wages of the operating force and keep the plant in first-class condition.

North Tonawanda, N. Y. C. J. MILLER.

Are Small Boiler Tubes Desirable?

In the sale of return-tubular boilers one of the problems frequently met with is the desire of purchasers to have installed in their boilers a large number of tubes, usually of smaller size, with the intention of increasing the horsepower rating of the boiler.

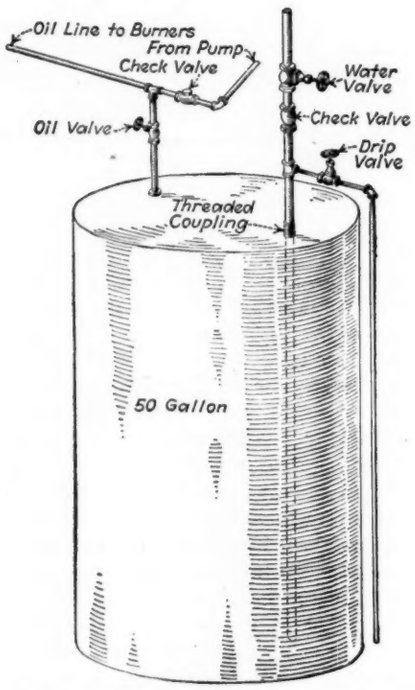
I have investigated this subject quite thoroughly and have thought that these extra tubes do not accomplish the desired purpose in most cases, and in many ways they are a detriment to the boiler, as they decrease the water-storage capacity, the steam-storage space and the steam-disengaging surface, and they also retard circulation. Furthermore, they make the proper cleaning of the tubes externally more difficult, and there are a greater number of tubes to clean internally.

New York City. N. S. RIGGIN.

[*Power* invites an expression of opinion from readers on this subject.—Editor.]

Oil-Burner Starting Tank

A small oil-burning boiler plant ran only from twelve to sixteen hours a day, thus leaving from eight to twelve hours when the steam might be shut off. A man was kept on duty at all times, as it was claimed that the boilers were not fired hard enough during the



FUEL-OIL PRESSURE STARTING TANK

running period to warm up the settings sufficiently to hold enough steam pressure to start the fuel-oil pump in the morning.

A new engineer, after sizing up the situation, decided he could use the night man to better advantage during the day, and in order to prepare for an emergency in case the steam pressure should drop during the night to a point lower than that required to start the fuel-oil pump, he obtained a 50-gal. steel drum and connected the fuel line between the pump and the burners to the top of the tank. Then, by cutting a 1-in. pipe thread on a ¾-in. pipe coupling and using this as a bushing through the top of the tank, he connected the 35-lb. pressure water service, extending the pipe to the bottom of the drum.

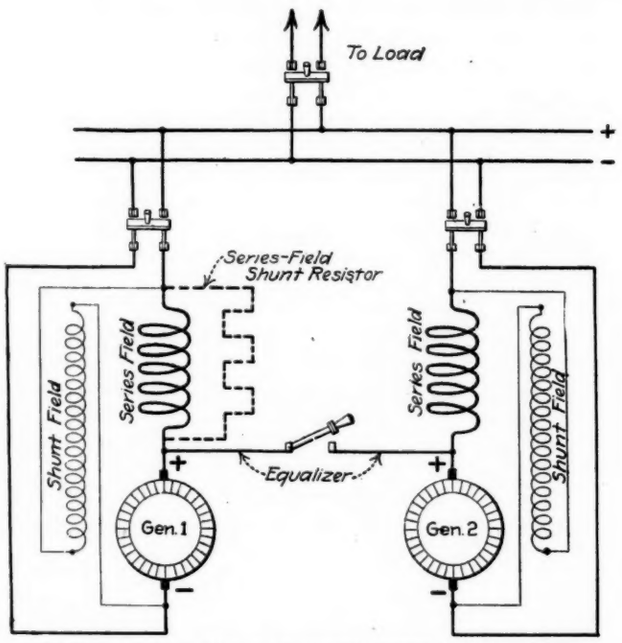
After the first filling (which was done before the last connections were made) the operation was comparatively simple. If it was found that the oil pump could not be started, the oil and water valves on the drum were opened and 50 gal. of oil at 35 lb. pressure was available. This was always enough to raise the desired steam pressure. In order to fill the drum with oil, the water valve was shut and the oil and drip valves opened, thus allowing the oil from the pump to replace the water. It was found necessary to empty the drum every day or two, or the oil would become so cold and sluggish that it would not atomize properly. To do this, the fuel for the last of the day's run was drawn from the drum, after which the drum was refilled with warm oil.

Norwalk, Cal. A. C. McMUGH.

Explosion of a Commutator!

"Explosion of a commutator" was the startling verdict of an operator better versed in alternating-current than in direct-current practice, when the generator under his care flashed over at the commutator. The machine in question was a direct-current over-compounded generator, operating in parallel with a similar machine about three miles distant.

Considerable trouble had been experienced in preventing one of the two generators from stealing the load from the other, and furthermore running its companion as a motor, until this one flashed over at the commutator. This was to be expected, and will always occur in similar circumstances, unless the machines are carefully watched, and the voltage regulated by hand, owing to the voltage characteristics of the machines; for, if for any reason, such as slight variations in speed, one machine should begin to carry a little more than its share of the external load its terminal voltage will rise; this will cause it to pick up still more load, consequently its voltage will keep on rising. This building up of voltage and load on one machine will continue until it is carrying the whole external load, and when the line voltage becomes greater than the no-load voltage of its companion it will pump energy into it and run it as a motor. The reversal of current in the series field of the second machine will then weaken its shunt field; this will weaken its counter-em.f. and cause it to draw a heavier current from the line; this heavier current still further weakens



CONNECTIONS FOR PARALLEL OPERATION OF TWO OVERCOMPOUNDED DIRECT-CURRENT GENERATORS

the field, causing a further increase of current through the machine, and so on, until the current becomes so large that it draws an arc around the commutator.

The moral of this tale is that over-compounded direct-current generators should never be operated in parallel unless it is possible to place them close to each other, as in the same plant, and interconnect them with a very low-resistance "equalizer." This is a large lead connected to each machine on the armature terminal between the armature and series field (see illustration).

The effect of this connection, when one machine tends to carry more than its share of the load, is to divide the increase of current between the two series fields and so equalize the voltage on both machines, and consequently the load.

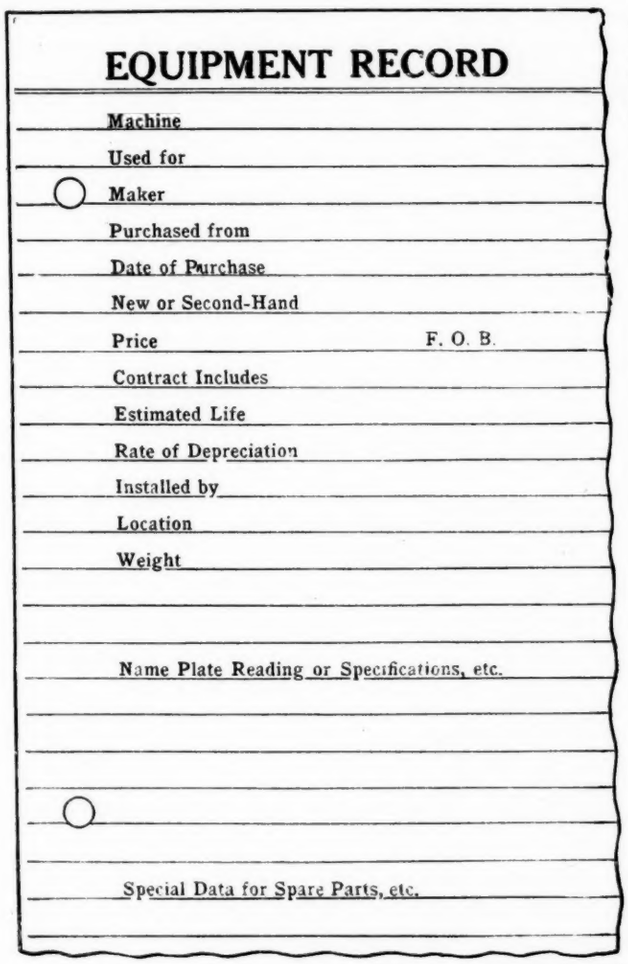
If it is desired to operate two over-compounded generators in parallel under such conditions that it is not possible to interconnect them through an equalizer—as, for instance, when the two machines are in different plants far from each other—their series windings should be shunted with a resistor, as indicated in dotted lines in the figure, so as to give them a flat-compound characteristic. They will then operate perfectly in parallel.

LEON L. POLLARD.

Fairfield, Mass.

An Equipment Record Sheet

The record that I use is a two-page sheet, suitable for a standard loose-leaf binder 8½ x 11 in., and is intended for keeping a record of equipment in a power plant. The front page, reproduced in Fig. 1, is for an installation record, nameplate reading and other information necessary for the ordering of repairs and supplies, and it does away with the trouble of hunting up these data each time parts are needed.


EQUIPMENT RECORD

Machine

Used for

Maker

Purchased from

Date of Purchase

New or Second-Hand

Price F. O. B.

Contract Includes

Estimated Life

Rate of Depreciation

Installed by

Location

Weight

Name Plate Reading or Specifications, etc.

Special Data for Spare Parts, etc.

FIG. 1. EQUIPMENT RECORD SHEET FOR POWER-PLANT

The opposite side of the sheet, Fig. 2, is for keeping a record of the repairs, additions, alterations, etc., giving the date and estimate number, the cost being inserted in the supplies and expense column or under the column covering the maintenance charges.

From this record the expenses on each piece of equipment can be determined, and it shows whether the machine is requiring an excessive amount of repairs, thus aiding in determining the proper time to replace the equipment with more modern apparatus.

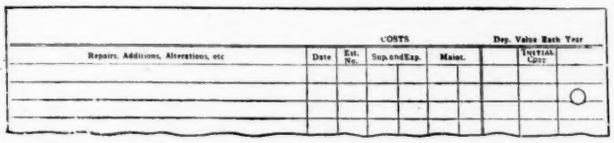

Repairs, Additions, Alterations, etc	Date	Est. No.	COSTS Sup. and Exp.	Maint.	Dep. Value Each Year	Initial Cost	

FIG. 2. RECORD SHEET FOR REPAIRS, ADDITIONS AND ALTERATIONS

Using loose-leaf sheets allows the addition or rejection of the sheets as equipment added or removed.

Hillsboro, Ill. JESSE L. BEST.

Steam Making With Fuel Oil

In the issue of Dec. 14, 1920, page 935, there is an article entitled "Steam Making with Fuel Oil." I disagree with the statement in the last paragraph that no higher efficiencies are ordinarily obtained with fuel oil than prevail in coal-fired plants. If this refers to large boiler plants with automatic stokers and under the supervision of a real combustion engineer, I think it is probably true, but one does not often find oil displacing coal in such plants.

In plants containing a number of hand-fired units experience has shown that the efficiency obtained with oil is much greater than that obtained with coal—not on test but in week-to-week operation; and the reason for this is easily explained. It is almost impossible to secure good firing with the proper control of the air, with the correct thickness of the fuel bed, regulation of draft, and all the other conditions that are necessary to good furnace efficiency. With oil it is much easier to maintain at least fairly good conditions.

It is my own experience, with several thousand of horsepower of boilers fired with oil and most of them in units of 200 hp. or less, that after making allowances for the difference of price per thousand B.t.u. in the fuel, the saving with oil was large—in fact, in a number of cases sufficient to pay for the cost of changing over, within a period of eighteen months.

As to repairs to settings I have not found that they were greater with oil than with coal and in many instances have found them to be less.

Taking boiler plants with hand-fired units at random, an efficiency of 60 per cent is about all that is to be found under the usual conditions of operation. Oil-fired boilers, on the other hand, will show 70 per cent more often than otherwise; and where a fair degree of supervision is exercised, an efficiency of 75 per cent is by no means uncommon.

Most of the oil-fired plants with which I am familiar will continue to burn oil at prices per thousand B.t.u. higher than coal. If an uninterrupted oil supply was assured for a period of five years, thousands of horsepower of boilers in New England would be converted over to oil burning, if the actual cost per B.t.u. of the oil was no more than the cost per B.t.u. of coal.

Providence, R. I. WARREN B. LEWIS.

Correct Height of Return-Tubular Boiler Above Grate

I have just been reading N. K. Bryan's comments on the article by Mr. Misostow on the correct height of return-tubular boilers. Mr. Bryan attempts to correct Mr. Misostow's figures and makes another mistake himself, but in the reverse direction. On page 1035 of the June 29, 1920, issue, Mr. Misostow, in the fourth line of the second column, states that there are 52 cu.ft. of gas to a pound of coal. He should have said 52 cu.ft. to the pound of gas. He was thinking straight, however, as in his calculation toward the bottom of the column he multiplies the 52 cu.ft. by the 20 lb. of gas credited to a pound of coal. Consequently, his figure of 2.17 sq.ft. is correct.

Mr. Bryan, on the other hand, says that there are 1,050 cu.ft. of gas for every pound of coal. This is correct, but in obtaining his 43.8 sq.ft. he must have again multiplied by 20, whereas he had already multiplied by 20 in obtaining the 1,050 cu.ft. Without this error his result would correspond with Mr. Misostow's.

Chicago, Ill. J. WINSTON.

Adjustment of Defective Field Coils

On coming into the engine room one morning I found the night engineer shutting down the engine driving the power generator. Upon investigation it was found that two of the generator shunt-field coils and rheostat were smoking hot. It was evident that the two field coils which remained cool were short-circuited, thereby allowing an excessive current to flow in the field circuit. The machine was a 100-kw. 500-volt four-pole belt-driven unit operating at 750 r.p.m.

This machine was the only one available at the time (for power service), and the plant is 35 miles from the nearest town where suitable repairs could be made, therefore something had to be done to keep the machine in service if possible. A 25-kw. 110-volt lighting generator, with its low-reading voltmeter and ammeter, proved to be an excellent testing outfit.

Two testing wires were connected to the blades of the main lighting-feeder switch, when in the open position (the voltmeter and ammeter connected to the generator required no new connections), the engine was started and the voltage of the generator raised to 70 volts. After first testing the field circuit of the 500-volt generator with a lamp, to see that it was not grounded, the coils here disconnected from each other, the test wires connected to each in turn, and current readings on the ammeter taken. Readings obtained on the four coils were: Coil No. 1, 5 amperes; No. 2, 5 amperes; No. 3, 7 amperes; No. 4, 8 amperes. By Ohm's Law resistance $R = \frac{\text{volts}}{\text{amperes}}$. For coils Nos. 1 and 2, $\frac{70}{5} = 14$ ohms; No. 3, $\frac{70}{7} = 10$ ohms and coil No. $4 = \frac{70}{8} = 8.75$ ohms. From the foregoing it was evident that since coils Nos. 3 and 4 had the lowest resistance, they were the faulty ones.

Assuming that coils Nos. 1 and 2 were all right, the total shunt-field resistance should be $14 \times 4 = 56$ ohms. Since the test showed $(14 \times 2) + 10 + 8.75 = 46.75$ ohms, the resistance of the field circuit was $56 - 46.75 = 9.25$ ohms low. This resistance was made up by winding 150 ft. of piano wire on an asbestos-insulated board. The resistance of the piano wire was determined by testing, and put in series with the coils.

The next step was to build up the voltage by speeding up the generator, to make up for the loss of magnetizing force; and this was done by trial. Full voltage was obtained at 825 r.p.m., corresponding to an increase of 15 r.p.m. on the engine speed.

Although it is not intended to leave the machine operating under these conditions, the old generator has been working as well as ever for two months; in fact better, since the change has given the machine an over-compound characteristic, and this in turn helps the governor, on sudden loads, to steady the voltage.

Great Meadows, N. J. STEPHEN DANS.

Calculating Flue-Gas Losses

In looking through the Dec. 7, 1920, issue of *Power*, I noticed the article by J. R. Darnell, on "Methods of Calculating Flue Gas Losses," and as I have occasion to use the formula,

$$W = \frac{4CO_2 + O_2 + 700}{3(CO_2 + CO)} \times C$$

in computing flue-gas losses, I am interested to know if the value of W as determined by this formula gives the weight of dry chimney gas per pound of carbon or per pound of fuel.

The same formula in a slightly different form is given in a treatise on "Principles of Combustion in the Steam Boiler Furnace," in which the author states that the value of W as given by this formula is the weight of dry chimney gas per pound of fuel, whereas Mr. Darnell says that it is the weight of dry chimney gas per pound of carbon.

I am inclined to believe that the latter statement is an error, as the author has used the value of W to compute the dry flue-gas loss per pound of fuel, since he states that the loss given in his problem, 2,078.4 B.t.u. = 14.3 per cent of the given value of the fuel, which is 14,480 B.t.u. C. B. HUDSON.

North Plymouth, Mass.

Replying to the foregoing, in the formula $W =$ the weight of gas per pound of dry coal and $C =$ per cent of carbon in coal divided by 100:

Where Mr. Hudson finds his point of contention is in the line where the equation is derived; that is,

$$W = \frac{48 + 6 + 700}{36} \times 0.8273 = 17.32 \text{ lb. of gas per lb. of carbon.}$$

This is an error and I am very glad Mr. Hudson has discovered it. Dry coal should be substituted for carbon. If we used the formula, $W = \frac{4CO_2 + O_2 + 700}{3(CO_2 + CO)}$, without multiplying by the percentage of carbon in the coal, then W would be equal to the weight of gas in pounds per pound of carbon. Multiplying by the percentage of carbon in fuel divided by 100, reduces the weight of the gas to terms of the particular fuel used.

I have also discovered that I have made another error in the figures given for determining the percentage of excess air: 11.33 lb. of air was required and 17.16 lb. of air was supplied; then, $17.16 - 11.33 = 5.83$ lb. of excess air; $5.83 \div 11.33 = 51$ per cent excess air.

East Chicago, Ill. JOSEPH R. DARNELL.

INQUIRIES OF GENERAL INTEREST

Testing Tightness of Boiler Rivet—How can it be determined whether a boiler rivet is driven tight? S. M. E.

To test the tightness of a rivet, place the thumb against one side of the rivet head and the forefinger of the same hand on the plate. Then, by striking the rivet head with a hammer, any looseness of the rivet may be felt.

Sloping Combustion Line of Diesel Diagram—I cannot get an indicator diagram from my Diesel having a horizontal combustion line. Why? G. L. N.

Although at one time all Diesels gave a horizontal combustion line on the diagram, at present many Diesels give a sloping line. Actually, this increases the engine efficiency and eliminates the difficulties with the cam profile encountered where attempting to secure combustion at constant pressure.

Taking Saturated Steam from Boilers Having Superheaters—All our boilers are equipped with superheaters, but one of our engines does not work well with superheated steam. How can this engine be supplied from the boilers? J. G. S.

For supplying the engine with saturated steam from the boilers, the steam would have to be taken out of the boilers by separate saturated-steam outlets, or might be taken out of the boiler connections to the superheaters between the saturated-steam space and the superheaters.

Proportion of Air for Explosive Oil Vapor—Is it true that an oil vapor will not be explosive unless it is mixed with an exact amount of air? W. L. M.

If a volatile oil is mixed with air, it will not explode if the proportion of the volatile be very small nor will explosion occur if the proportion of oil is large. The explosion range with gasoline is from 2 to 4 per cent. of fuel vapor to 100 per cent of air. However, explosions frequently occur with exceedingly rich mixtures. This is due to the outer edges of the mixture being of the right proportion, and on igniting will so diffuse the remainder through the air that the entire oil charge will explode.

Heating Water by Electricity—If 25 kw. of three-phase electrical power, at 220 volts 60 cycles, are available at no cost, how much water may be heated per hour to temperatures ranging from 120 to 200 degrees Fahrenheit? L. R.

One kilowatt totally expended in heat produces 3,415 B.t.u. per hour; therefore 25 kw. will produce $25 \times 3{,}415 = 85{,}375$ B.t.u. per hour. If no heat were lost, this would raise the temperature of 1,000 lb. of water through 85.4 deg. F. in one hour, or 500 lb. through twice the number of degrees. It should be possible, by carefully packing the heater, to reduce heat losses to about 10 per cent, and to heat about 457 lb. of water per hour from 32 to 200 deg. F., or 873 lb. from 32 to 120 deg. F.

Parallel Operation of Alternators—When two alternators are operating in parallel, why is it impossible to regulate the load on each machine by varying their field excitation, as in the case of direct-current machines? D. R. A.

The only way to control the load distribution between two alternating-current generators operating in parallel, is to vary the speed of the prime mover; for any attempt to raise the voltage on one machine by increasing its excitation will simply set up a circulating wattless current between the two machines, which will weaken the field in the overexcited machine and strengthen it in the other, resulting in a slight increase in the line voltage, but practically no change in the load distribution.

Hunting Action of Engine Governor—What causes hunting action of a flyball governor? R. D.

When an alteration of speed begins, the governor does not act immediately, because it can operate only after a change of speed has occurred, and a change of position does not affect the engine speed immediately, on account of both the inertia of the moving parts of the engine and the energy of steam which has passed the control of the governor. By the time the change in engine speed has had full effect on the governor, it is forced beyond the position necessary to bring the speed back to normal. Then for the same reasons the governor is forced into a position of overcontrol in the opposite direction. Hence hunting action may be the result of over-sensitiveness of the governor, or may be caused by friction, or the over-dampening by dashpots of the governor, first causing it to be delayed and then overreaching to a changed position; and in slow-speed engines the hunting is aggravated by a wide difference of mean effective pressure in opposite ends of the cylinder.

C. and F. Temperatures That Exactly Correspond—At what temperature on the Centigrade and Fahrenheit thermometer scales do the degrees exactly correspond with each other? O. W.

On the Centigrade scale the zero is the melting point of ice, and the point corresponding to the temperature of boiling water, under standard conditions called the boiling point, is marked 100; hence there are 100 units called degrees for the interval between the melting point and the boiling point. The Fahrenheit scale is marked 32 for the melting point and 212 for the boiling point; hence there is an interval of 180 degrees between the fixed points. The value of a degree on the Fahrenheit scale therefore is $\frac{5}{9}$ of a degree on the Centigrade scale, or an interval of the Centrigrade scale is equal to $\frac{9}{5}$ as many degrees of the Fahrenheit scale; but since the melting point on the Fahrenheit scale is marked 32, that number must be added to give the Fahrenheit reading; that is, where f is the Fahrenheit reading and c the Centigrade reading we would have

$$(1)\ f - 32 = \tfrac{9}{5}c, \text{ or } (2),\ f = \tfrac{9}{5}c + 32$$

The temperature for which both scales read the same is obviously below zero and therefore the common reading would be negative. Calling the common scale reading T and substituting in (2) for f and c gives $T = \frac{9}{5}T + 32 = -40$. In other words the scales exactly correspond in number of degrees when the temperature measured by either is 40 deg. below its zero.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Steel Smokestacks*

By W. E. Goldsworthy

From the viewpoint of a stack manufacturer there are four principal types of smokestacks: (1) The self-supporting; (2) the guyed; (3) the interior office building; (4) the exterior office building.

The self-supporting stack is the largest and most difficult to design, being often built of great diameter and height, sometimes 20 to 25 ft. in diameter and 200 to 300 ft. high. The stresses in a self-supporting stack are largely dependent on the ratio between the diameter and the height. If the ratio does not exceed one to twenty the stresses will not be high for a stack of ordinary proportions. For instance, in a stack 5 ft. in diameter by 100 ft. high, or 6 ft. in diameter by 125 ft. high, the stresses will be low and an economical stack can be built.

This does not hold so nearly true on the large diameters but is correct up to 10 ft. diameter. It is usual to flare the bases of these stacks, beginning at a point about one-sixth of the height from the bottom and increasing the diameter until at the bottom it is one and one-half times the diameter. No steel less than ¼ in. in thickness should be used. There is no economy in using the lighter metal as fabrication and erection cost as much as for the heavier metal.

How Guyed Stacks Should Be Built

Guyed stacks are a much simpler proposition, but in the design of these there is much opportunity for improvement. As long as one can remember it has been and still is the custom to build guyed stacks of different thicknesses throughout, the upper part lighter than the lower. The great majority of stacks of this type which have been built are built wrong and have wasted the money of the men who paid for them. The reason for this is that the upper part of a stack wears out first. There is a point usually within the upper thirty feet of a stack where the gases condense and precipitate a mild sulphuric acid on the stack which sets up a rapid corrosion. The better practice is to decide on a thickness of five-sixteenths or a quarter inch and use that from the bottom to the top. The stresses in guyed stacks are negligible and due only to the weight of the steel, as the guys take all of the wind load. Most engineers specify these stacks to have the lower course telescope into the upper one. It is our practice to reverse this, making the upper course telescope into the lower one. The reason for this is that the stacks built in the old way streak in the first rainstorm, while those built the other way are free from streaking. The old way provided a little shelf at each joint for the moisture or condensation to settle on, and aids corrosion, while with the changed construction this condition does not exist and corrosion will be minimized. Interior office building stacks present many problems to the designer, the main questions being those of thickness and style of support. A uniform thickness throughout of $\frac{5}{16}$ or ¼ inch is good practice. The stacks in the Woolworth Building and Equitable Building are $\frac{5}{16}$ in. thick throughout, the diameters being 6½ ft. and 11 ft. respectively. The best method of support is from the structural steel of the building at about every second or third floor. This involves making a section 25 to 35 ft. long, or about the length of a gondola car. Each section when made takes care of its own expansion if a slip joint is used. It is important to remember that expansion in a stack of this character is a necessary consideration. There could easily be an expansion of six to twelve inches in a stack for a high office building.

Exterior Office-Building Stacks

The exterior office building stack has special conditions of its own. Owing to its length and exposure the gases condense freely and much sulphur-laden moisture is precipitated in it so that corrosion is quite rapid. It is good judgment to make these quite thick as the cost of shop labor, overhead and erection would not be much greater on the heavier stack than on the light one, while the life would be much longer. Stacks of this type should be ¼ in., $\frac{5}{16}$ in or ⅜ in. thick, depending of course somewhat on the size, and should carry their weight to the foundation. They are supported by U bands at about every story, made loose, so that while they support the stack they do not prevent it from expanding. On this type of stack the upper courses should telescope into the lower ones, otherwise the stacks will streak beautifully and a new job will soon look like a second-hand wreck. These exterior stacks usually run above the roof anywhere from 15 to 30 feet. Exterior stacks should be kept well painted, every year if possible, preferably with a good quality graphite paint, as this paint stands the heat better than most lead paints.

Self-supporting and guyed stacks should be provided with means of reaching the top for attaching painters' rigging. Self-supporting stacks are usually provided with a ladder and a painter's trolley, guyed stacks usually with a painter's pulley and a flexible wire reaching to the ground. All stacks should have a clean-out door at the bottom. Hoods on top of the stacks are unnecessary unless the stack is out of use for a long period. They interfere with the draft and should be avoided if possible.

*Abstract of an article presented at the annual meeting of the American Society of Heating and Ventilating Engineers, January, 1921.

Combustion of Lignites and High-Moisture Fuels

One of the interesting technical papers read at the annual convention of the Stoker Manufacturers' Association at White Sulphur Springs, W. Va., was presented by T. A. Marsh, chief engineer of the Green Engineering Co. The author outlined the lignite-producing districts of North America, gave characteristics of the lignites in the various fields, analyses of the fuel, draft requirements and other data. Much of this fuel has been burned successfully. Good results have been obtained from lignites containing up to 35 per cent of moisture. With certain Colorado high-moisture coals combustion rates up to 60 lb. per sq.ft. of grate area have been obtained, the principal requirements being large grate area to burn the relatively greater amount of coal necessary to produce a horsepower and long arches in conjunction with high bridge walls to concentrate the heat of the furnace in the vicinity of the gate to produce the proper degree of ignition.

In his introductory remarks the author stated that many of these fuels contain more than 40 per cent of moisture and less than 6,000 B.t.u. per pound when mined, and that from such fuel it is evident that even after obtaining satisfactory combustion the net heat delivered to the boiler would be small, owing to the low initial heat value and the loss from evaporation of the moisture in the coal.

Lignite Deposits in North America

In North America the lignite deposits occur in five main areas: The North territory and Alaska, Alberta and Saskatchewan, North Dakota and Montana in the Fort Union Region, Texas and the Mississippi region including Mississippi and southern Alabama. In addition there are certain areas in Wyoming and Colorado bearing high-moisture coals containing from 20 to 30 per cent of moisture. On the average lignites contain from 20 to 40 per cent of moisture when mined. When burning this fuel the moisture should be driven off in the furnace. After the fuel is dry the volatile gases burn off rapidly, leaving a bed of fuel burning with little flame similar to charcoal, which burns out to a fine, light, white ash. Unusually high draft is not essential for high combustion rates as it is possible to burn liberal amounts of lignite as fired per square foot of grate at furnace drafts running from 0.15 in. of water when burning 20 lb. of lignite per square foot of grate area to 0.37 in. when burning 40 lb. of this fuel per unit area of grate. In all calculations of draft involving areas of boiler passes, flues and chimneys, allowance must be made for the relatively large amount of this fuel required per horsepower. For example, with Malakoff lignite containing 7,124 B.t.u. and burned at 71.3 per cent efficiency, it requires 6.6 lb. of coal as fired to develop a boiler horsepower-hour. Following is given a typical analysis of North Dakota lignite: Moisture, per cent, 41; volatile, per cent,

24; fixed carbon, per cent, 27; ash, per cent, 8; B.t.u. (commercial), 6,241; B.t.u. (dry basis), 11,932. On account of its high moisture content no successful commercial method has been found for burning this fuel. Large areas of it are waiting for the further development of the art of combustion.

That part of the Dakota lignite field extending beyond the Canadian border, however, contains lignites enough lower in moisture content to make possible their successful burning. The fuel in question is called Souris lignite with the following typical analysis: Moisture, per cent, 29.7; volatile, per cent, 30.3; fixed carbon, per cent, 31.0; ash, per cent, 9.0; B.t.u., 10,775. This fuel is being burned successfully in many plants. Large grate areas are necessary, the ratio usually being at least 1 sq.ft. of grate to 30 sq.ft. of water-heating surface. In the furnace a liberal igniting arch is a necessity and a second requirement is a vertical bridge wall or, preferably, an arch at the rear reflecting the heat forward and deflecting the gases forward over the fuel, these requirements referring to a chain-grate installation. Such a furnace has ignited and burned 30 lb. of Souris lignite per square foot of grate area per hour.

The Lignites of Colorado

In the lignites of Colorado 30 per cent is about the maximum percentage of moisture found. The following analysis of Pike View lignite is typical: Moisture, per cent, 23.73; volatile, per cent, 35.25; fixed carbon, per cent, 33.23; ash, per cent, 7.79; B.t.u. (commercial basis), 8,511; B.t.u. (dry basis), 11,116. Danville lignite from the same state contains a higher percentage of ash and slightly less moisture. Both are found in the Colorado Springs district. Many plants are using these fuels and are obtaining high combustion rates and efficient results.

Leyden lignite, mined in Jefferson County, Colorado, analyzes on the average as follows: Moisture, per cent, 23.08; volatile matter, per cent, 32.43; fixed carbon, per cent, 32.07; ash, per cent, 12.42; sulphur, per cent, 0.20; B.t.u. per lb. as fired, 8,865. It is to be noticed that the fuel is high in moisture and relatively high in ash, the non-combustible totaling 35.50 per cent. This fuel is being used at the Platte Street Station of the Denver Tramway Co. It is burned under Stirling boilers equipped with double chain grates 13 ft. long, their active area bearing a ratio to the water heating surface of 1 to 44. With an arch having a horizontal measurement of 10 ft. and pitched 4 in. to the foot, the heat of the furnace is reflected up to the stoker gate to insure the ignition necessary for this high-moisture fuel. The furnace has 4.7 cu.ft. of volume for each square foot of grate area, and if the installation were being made today this volume would be enlarged.

In operation the boilers frequently carry from 250 to 300 per cent of rating and 60 lb. of this fuel can be burned per square foot of grate area per hour. The thickness of the fuel bed carried is usually 10 in. Three factors have a bearing on the combustion performance previously indicated. One is the exclusion of air around the stoker gate and even through the coal in the stoker hopper, the latter being provided with a cover fitting around the coal spouts. Another feature is the use of preheated air drawn from the basement, which in turn is supplied from the turbine room. This air is delivered under the grates at about 80 deg. F. The third feature is the preparation of the coal for burning. It is crushed to the size of about 1¼-in. screenings, and although it contains 24 per cent of moisture when mined, approximately 5 per cent more water is added by sprinkling the coal just before it goes to the crusher. By wetting the fuel, or "tempering" it as it is commonly termed, the benefits are physical rather than chemical, but this action has a most important bearing on combustion rates.

Experimental Work with Texas Lignites

Two years ago S. B. Flagg, formerly of the Bureau of Mines, carried on some experimental work with Texas lignites at Fort Worth, obtaining a combustion rate of 60 lb. of coal per square foot of grate area per hour on a chain-grate installation. The fuel contained in excess of 30 per cent moisture. High-set long arches contributed to the results obtained. It should be stated, however, that the vast lignite fields of Texas are practically undeveloped. In this section of the country lignite must compete with coals of Texas as well as those of Arkansas, Oklahoma and New Mexico, and with oil and natural gas at comparatively cheap rates. With better fuels available the development of furnaces for burning lignite has been retarded. Notwithstanding, many of these lignites have been burned with excellent results on chain grates. A stoker of this type containing not only an ample ignition arch, but also a reverse arch from the bridge wall bringing the heat forward over the fuel bed, gave the results listed in the following:

	Malakoff	Treadlow
Moisture, per cent	29.93	29.80
Volatile, per cent	30.96	31.34
Fixed carbon, per cent	25.45	23.71
Ash, per cent	11.66	13.15
B.t.u. (commercial)	7,124	6,906
B.t.u. (dry basis)	10,314	9,838
Type of stoker	Chain grate	Chain grate
Type of boiler	Water tube	Water tube
CO_2 at damper, per cent	11.81	12.2
Coal per sq.ft. per hr., lb.	30.6	31.6
Draft in furnace	32	24
Combined efficiency, per cent	71.3	69

With an inclined coking plate chain grate the following results were obtained with Calvert Texas lignite:

Name of Fuel	Calvert (Tex.) Lignite
Moisture, per cent	30.16
Volatile, per cent	38.33
Fixed carbon, per cent	24.03
Ash, per cent	7.48
B.t.u. (commercial)	7,462
B.t.u. (dry basis)	10,669
Coal per sq.ft. of grate per hr., lb.	36.4
Furnace draft	34
CO_2 at damper, per cent	11.2
Combined efficiency, per cent	67

Considering that the moisture content of these fuels is from 25 to 30 per cent, the efficiencies of 69 to 72 per cent are creditable. It is evident that it is not possible to obtain the high efficiencies for these fuels that can be obtained from low-moisture coal. Such fuels as the Calvert lignite containing 30 per cent moisture require 372 B.t.u. per pound simply to evaporate the moisture in the fuel and heat the resultant steam to a temperature of 500 deg. F., assuming a temperature in the boiler room of 80 deg. F. The heat thus used is 5 per cent of the total heat in the fuel as fired and must detract directly from the efficiency of steam generation. Under average conditions the temperatures developed in the furnace are not high. In the case of lignites they are probably not over 2,200 deg. F. even at high rates of combustion. This would indicate that no difficulties should be encountered from clinkers adhering to the side walls, and experience with lignites has borne this out.

Red Lodge and Sheridan Coals

Ever since the commercial development of coal mining in the Red Lodge District of Montana and the Sheridan district of Wyoming, 35 years ago, there have been constant attempts to burn these fuels, but the best results obtained fell short from the standpoint of efficiency and capacity. On the average 60 per cent over-all efficiency and 140 per cent of builder's rating for a period of over two hours duration were obtained. Most of the early attempts to burn this fuel failed because of the problem of ash discharge and the difficulty of igniting the coal promptly and in sufficient quantities. Recently, these difficulties were solved by using a chain grate with a long arch having a steep pitch, the stoker providing a satisfactory fuel bed and the arch the concentration of heat necessary at the stoker gate.

In the coals mined in the Red Lodge District the ash is largely due to dirt occurring as partings too thin to be separated in mining. The sulphur content is low, and in general the structure of the coal is such that it can be broken into marketable sizes with only a small percentage of fine coal and slack remaining as residue.

Bear Creek coal from the Red Lodge district has the following average analysis: Moisture, 15.48; volatile matter, 35.46; fixed carbon, 34.80; ash, 14.26; B.t.u. as fired, 9,354. In a chain grate furnace having a long sloping arch this Bear Creek coal ignites freely. In a certain installation the ratio of active grate area to water heating surface was 1 to 37.4. A fuel bed 2¾ to 3 in. thick was found advantageous

and chain speeds approaching 12 in. per minute were used. The high chain speed coupled with high moisture content and a thin fuel bed necessitated exceptional concentration of heat at the stoker gate. In addition operating conditions were improved by slightly moistening the fuel before burning. During combustion a large amount of light particles leave the grate. These ignite and give off an intense white flame.

For minimum combustible in the ash the coal should be of uniform size, about ¾-in. screenings, and without an excessive amount of fine coal. Results of two tests with this Bear Creek coal, one at medium rating and the other at high rating follow:

Combustible in ash, per cent	20.27	18.31
Draft in furnace, in.	0.18	0.22
Flue-gas temp., deg. F.	505	613
CO_2 at uptake, per cent	12.5	12.97
Coal burned per sq.ft. of active grate surface, lb	28	38
Per cent builder's rating developed	158	209
Combined efficiency, per cent	75.3	75.6
Duration of test, hours	8	8

Another coal from this district is known as Red Lodge. In general it is similar to Bear Creek coal but, owing probably to its slightly higher volatile content, ignites a little more freely and burns to a clean white ash. In two tests made on this coal combined efficiencies of 73.1 and 77.8 were obtained when burning per square foot of active grate area 31 and 30.5 lb. of coal, respectively.

Southeast of the Red Lodge district in Montana, just across the Wyoming state line, is the so-called Sheridan coal field. Exposed to dry air, it undergoes a rapid change by the loss of its free moisture, which causes the coal to crack. Although weakened by this shrinkage, the coal will not crumble for an indefinite period if properly protected from the weather. When it is subjected to alternate wetting and drying, however, it breaks into small lumps and is finally reduced to dust. Though the coals of the Tongue River group of the Sheridan field contain a comparatively high percentage of moisture and disintegrate on exposure like the lignites, they do not show a woody structure, although some of the coal from the other groups of the Sheridan field do have this woody structure. An average analysis of the Sheridan district coals shows the following percentages: Moisture, per cent, 20.52; volatile matter, per cent, 31.23; fixed carbon, per cent, 30.00; ash, per cent, 9.25; B.t.u. as fired, 9,096. The coal ignites freely when used in a furnace having a proper igniting effect. To secure the best results, it must be burned with a thicker fuel bed and slower chain speed than is desirable for the coals of the Red Lodge district. Results of two tests made on this coal are as follows:

Draft in furnace, in.	0.196	0.16
Flue-gas temp., deg. F.	552	...
CO_2 at uptake, per cent	12.6	11.8
Pounds coal burned per sq.ft. active grate area	35	30
Per cent builder's rating	195	152
Combined efficiency, per cent	78.1	76
Duration of test, hours	8	8

It will be of interest to notice that the test at 152 per cent of rating was conducted under normal operating conditions, no provision being made for maintaining a steady load.

While the tests reported were selected from a series and are unusually good, they represent no extraordinary efforts with these furnaces.

Economizers*

By W. F. Wurster

The economizer was first used in 1845 by Edward Green. It consisted of a circular group of twenty cast-iron tubes four inches in diameter by nine feet in length connected at the top and bottom to hemispherical chambers, the cold water being introduced into the lower one and after rising through the tubes passing on to the boiler through a branch at the top. The modern economizer is built in sections, each of which is composed of a top and bottom header with the necessary tubes. The top headers are machined on the sides so as to fit closely together, thus preventing the escape of gases from the economizer or the infiltration of air. Adjacent headers have a semicircular groove cast vertically on opposite sides, and when the sections are placed in position, these grooves come together, forming a hole for the passage of the scraper chain.

Sections are built with four to twelve tubes each. These tubes vary from six to twelve feet in length and are $4\frac{2}{16}$ inches in diameter. The number of sections in an economizer is a multiple of four, which is due to the fact that the pulley on the scraper-driving mechanism operates the scrapers for four sections. The exterior of each tube is kept free from soot by means of scrapers which travel continuously up and down the outside of the tube at a slow speed. The soot falls into the soot pit beneath the economizer whence it can be removed at regular intervals. The sectional covers consist of two steel plates with about two inches of asbestos or insulating material between. This method of inclosing one or both sides of the economizer is now preferred to the older method of bricking in the machine, as it permits easy access for the purpose of inspection and cleaning.

Determining the Saving Possible

In determining the saving that can be made by an economizer, various factors are taken into consideration. The most important of these are the temperature and quantity of gases available and the initial temperature and quantity of water that is to be heated. In an industrial plant containing five 300-hp. boilers, one of which is held as a spare, one economizer is capable of handling the feed water. In this case the steam pressure is 150 lb., gas temperature 525 deg., 80 lb. gas per boiler horsepower available for heating the feed water, which has an initial temperature of 120 degrees. An economizer of 320 ten-foot tubes gives a rise of 97 deg. in temperature, or a saving of 8.7 per cent of the fuel burned. This plant operates ten hours per day and burns 24 tons of coal at a cost of $151.70. The economizer saves 8.7 per cent of this amount, or $13.20 per day, and in a year of 310 days the machine saves $4,100. This machine installed costs $12,000, and with due allowance for interest, depreciation, maintenance and repairs, shows a net return of about 20 per cent on the investment.

In addition to the savings made by an economizer there are further advantages to be obtained: First, an increase in the capacity of the plant; second, there is always a large supply of feed water on hand which is a great help in handling fluctuating and peak loads; third, the boiler is protected from cold feed water, which reduces expansion and contraction strain. Another advantage is the fact that a large portion of the impurities found in the water used for boiler feeding is precipitated in the economizer because of the slow motion of the water in the tube. These precipitates can be blown off or washed out as a sludge, whereas if they had been allowed to form in the boiler, they would have baked on the tube as a hard scale, which it is difficult to remove. The economizer can usually be cleaned by means of a stream of water from a hose connected with the service line. Many economizers are operating on the waste gases from cement plants, oil stills and other industrial operations, where the waste gases are discharged at a temperature of over 350 deg. The increase in the cost of fuel, both coal and oil, indicates that the demand for economizers will be greater than heretofore.

*Abstract of article presented before the annual meeting of the American Society of Heating and Ventilating Engineers, January, 1921.

At the recent meeting of the National Association of Practical Refrigerating Engineers at Chicago there was a new spirit of enthusiasm and progress. C. W. Kohler, the newly elected president, is sending out a call to the practical refrigerating engineers of the country to join local associations where they exist, to organize local associations in all cities which can support them, and to invite all refrigerating engineers who are in the smaller cities and who cannot attend local meetings to become members of the national body and participate in its benefits. The association is one of operating refrigerating engineers, comparable to the National Association of Stationary Engineers in its composition and methods. Education is the cornerstone upon which it is built, and Mr. Kohler, who may be addressed at 2629 Orchard St., Chicago, Ill., will be glad to furnish information to any who are interested.

Condensed-Clipping Index of Equipment

Patented Aug. 20, 1918

Hoist, Payne Hydraulic Ash

F. S. Payne Co., Cambridge, Mass.

"Power," 1920.

This hoist consists of a brass cylinder, steel plunger and brass-lined valve with the necessary chains and other appurtenances. The water consumption of this hoist is invariably less than two feet per trip. The plunger rests on a cushion of water which permits the mast arm to revolve so that ash cans can be deposited at several points around the upper landing. This apparatus is self-maintaining and does not require skilled labor for erection or for satisfactory operation.

Pump, Moody Spiral

I. P. Morris, Dept. of the William Cramp & Sons Ship and Engine Building Co., Philadelphia, Pa.

"Power," Dec. 7, 1920.

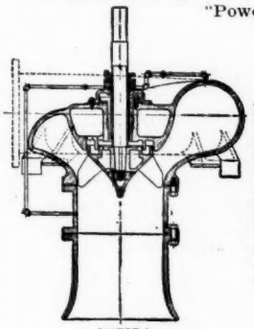


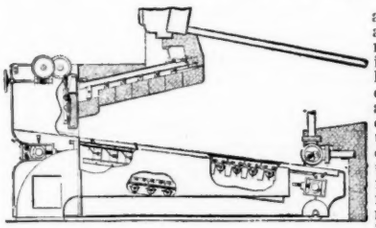
FIGURE 5
Sectional Elevation of Pump

This is a low- and medium-head, high-speed pump, the impeller of which is of the single suction type. As it overhangs on the end of a shaft, but one bearing and one stuffing box are required. The opening between the impeller vanes are large, and the design is such that the danger of plugging the pump with foreign material is avoided. This pump is designed to deliver 12,000 gal. of water per minute against a head of 16.5 ft. at a speed of 692 revolutions per minute.

Grate, McKenzie Forced-Draft-Chain

McKenzie Furnace Co., Chicago, Ill.

"Power," Nov. 30, 1920.

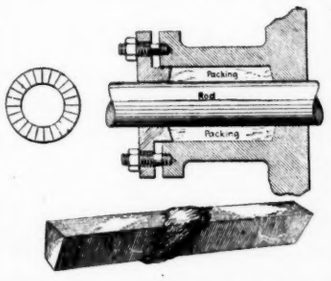


This stoker consists of a main air duct entering at the front of the furnace and extending back in the slide wall the full length of the stoker. It can be pulled out with the stoker. Transverse air chambers with perforations in an arched top discharge the air across the grate. Provision is made for admitting air from under the stoker by natural-draft operation. The arch is of the flat suspended type. The water back is unusually designed, the inlet and discharge are at the same end, the water entering through a three and a half inch tube extending within a larger pipe 8 in. in diameter. The return is through the larger external pipe. When it is necessary to clean out the water back a hose is attached to the 1-in. nipple leading to the 3½-in. pipe.

Packing, "Tiptop" Plastic Metallic

France Packing Co., Tacony, Philadelphia, Pa.

"Power," Nov. 30, 1920.



This packing is made of soft, shredded anti-friction alloy, permeated with graphite and mica and compressed into bars, rings and in loosely wound forms. When made in bars, it is cut the required length to fit the stuffing box lengthwise, the length being packed around the rods lengthwise. The packing is soft and is easily compressed against the stuffing box wall and the piston rod. The packing is used with Corliss valve stems, with steam and water valve stems, small valve stems on engines or pumps, pump water plungers, expansion joints or on any rod or stem that travels in line. It is made for superheated steam and will not harden in the stuffing box.

Pump Valve, Improved Kinghorn

The Dew Valve Co., Inc., 129 Broadway, New York City

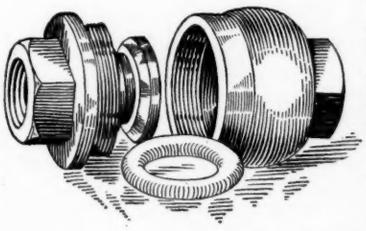
"Power," 1920.

This pump valve is adaptable for pumps that are used for heavy-gravity oil, boiler feed and elevator service, where the load changes are frequent. The main feature is the sliding guard instead of a stationary one, which makes it more positive in action. The valve disc is made of a special metal which gives it lasting qualities.

Valve, Paul Cold Water Check

Fort Wayne Engineering and Manufacturing Co., Fort Wayne, Ind.

"Power," 1920.

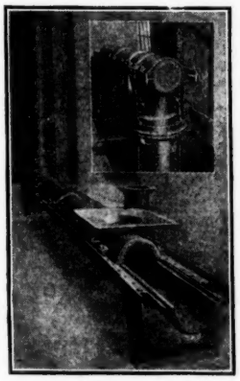


This valve is designed for cold-water use and wherever an ordinary check valve is desired for pressures up to 100 lb. per sq.in. On account of its rubber ring it cannot be used for hot water or for oil. It can be used in section lines where the vertical lift is moderate. The seat is separate from and inside the valve body. The valve consists of two metal parts and a rubber ring valve. There are no moving parts and no seats to regrind. The rubber valve is easily removed. The valve can be placed in a pipe line running at any angle.

Conveyor, American High-Duty Ash

American Steam Conveyor Corporation, Chicago, Ill.

"Power," Nov. 30, 1920.

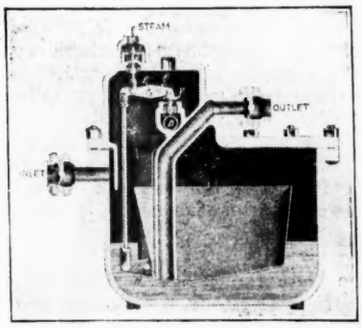


This steam-jet conveyor is designed with the pipe line intake tees and fittings made of semi-cylindrical sections bolted to a steel frame of parallel T-bars and angles. One section fits into another longitudinally through the use of a tongue and groove, and to give air-tight construction the joints are cemented. The half sections are staggered with a view to equalize the wear. Its construction insures a straight pipe line, and there is no air leakage to reduce the capacity of the system. The internal diameter of the pipe line is 9 in., and the diameter of the intake is 8 in.

Trap, Strong Vacuum and Pumping

The Strong, Carlisle & Hammond Co., 200 Congress St., Boston, Mass.

"Power," Nov. 23, 1920.



This trap consists of a body, valve chamber, open float bucket, vacuum or equalizer valve and steam valve. With the bucket afloat the steam valve is on its seat and the equalizer valve is open. Water comes into the trap and fills the bucket, which sinks and pushes up a rod which closes the equalizer valve and opens the steam valve. The equalizer valve, in closing, cuts out the trap from the equalizer pipe. When the steam valve opens, live steam is admitted to the trap and discharges the water from the inside of the bucket.

Clip, paste on 3 x 5-in. cards and file as desired

Congress Considering Coal Regulation

Senator Calder's Committee on Reconstruction, which has been investigating the bituminous-coal industry, has finally submitted a bill aimed to eliminate profiteering in the coal industry. This measure, the Federal Coal Bill, was introduced Jan. 12. In the Senator's opinion further legislation will be necessary, but he urges passage of the present bill for immediate relief. The two strongest "teeth" of the law provide for licensing coal operators and for putting the President of the United States in direct charge of the industry in case of an emergency.

Licenses will be required only of operators or dealers whose gross sales during the preceding fiscal year exceeded $50,000, and failure to secure this license will be punishable by a fine of up to $5,000 or by two years' imprisonment or both. The chief requirement for keeping the license will be at first little more than for the operators to make regular and complete reports of their business. It is thought that the publicity resulting from impartial reports of the various districts of the country will be a big obstacle in the way of overcharging such as exists today.

However, in order to guard against the possible failure of publicity, a second and more drastic provision is included, giving the President power, whenever the Federal Trade Commission declares the existence of an emergency, to fix maximum prices, to direct production and distribution and, if necessary, to take charge of the actual selling of coal to the people. This extra authority lasts only as long as the emergency by which it was originally justified.

An effort is made in additional clauses to prevent the pyramiding of prices through resales from one dealer to another where each adds his profit and piles up the total; brokers' sales are taxed above a certain margin for coal bought directly from the producer, and much more heavily in subsequent unnecessary resales between brokers. This tax, however, is applicable only to those dealers whose yearly sales are not less than $500,000. This is intended to force a reduction in the number of dealers handling coal between mine and consumer, and consequently to bring prices nearer to actual cost by the elimination of numerous profits. For the same purpose the bill provides against interested dealings through subsidiary or affiliated concerns; these provisions resemble part of the Clayton act prohibiting such dealings on the part of the railroads.

Authority is given Federal officers to search the books of any person or corporation under investigation and to subpœna the attendance of witnesses and the production of documents that may furnish any evidence needed in an investigation.

While the proposed law has its good points and many feel that it will serve its purpose temporarily, considerable dissatisfaction is expressed with it on the ground that it is not strong enough. It has been pointed out that profiteers in other lines have been fiercely attacked by publicity, but do not seem to have been greatly hampered by it in their operations. Higher taxes on resales may, it is believed by some, simply be added on to pyramid the selling price still higher. The old cry of governmental interference is of course being raised by the operators, but public opinion today inclines strongly to the belief that the coal business is too closely interwoven with national welfare to claim exemption from regulation, as might be done by a strictly private enterprise. On the other hand, a praiseworthy feature of the bill is that it creates no new governmental machinery, but aims to use experienced agencies already in existence, chiefly the Federal Trade Commission, the Interstate Commerce Commission and the Geological Survey.

It is possible that the House and Senate may, in discussing the bill, amend and revise it, and so when it finally becomes law it may be found to be a really effective agency in suppressing the present gouging tendencies of coal operators and dealers.

Imports of coal into the Netherlands for the first nine months of 1920 were 2,190,979 metric tons, a little less than for the same period last year. The estimated domestic production for this year is only half of the average for the past seven years.

A Newcomer in Our Midst

Power extends a hearty greeting to the newest arrival in the field of technical journalism, *Scientific Lubrication*, the journal of the recently organized American Society of Lubrication Engineers.

The first issue is just out and presents a pleasing appearance. It is printed on a good grade of paper, contains forty-eight 9 x 12-in. pages and impresses one as a high-grade publication. The only illustrations in the text of the first issue are a portrait of Mr. Parrish, president of the society, and a few line cuts; this sparseness of illustrations may be considered as detracting somewhat from the journal's value, but on the other hand the text is most varied and comprehensive, dealing with both the sales and the technical aspects of lubrication.

Water-Relief Valve Would Have Prevented This Explosion

On Dec. 28 a cast-iron sectional hot-water boiler in one of Detroit's finest residences exploded, causing one death and a property damage of about $10,000. The boiler, which was one of two installed for heating the building, was fitted with stop valves on flow and return lines, but was not equipped with a proper water-relief valve.

On the date given, the butler had fired up the boiler without opening the stop valves and the explosion followed as a matter of course. The boiler itself was hurled some distance from its position and completely wrecked, injuring the butler so badly that he died two days afterward. This explosion shows the necessity for fitting hot-water boilers with the diaphragm-operated water-relief valve specified in the A. S. M. E. Boiler Code.

The McCormick Bill, or "Departmental Reorganization Act," now before Congress, provides for the reorganization of the Department of the Interior into the long sought Department of Public Works. It also plans to add a Department of Public Welfare, and to reorganize the Departments of Commerce, State and Justice. The bill provides that if passed it shall go into effect July 1, 1921. The idea of the act is to remove the duplication of effort and unbusinesslike methods which are now to be found in the various Government departments. Various boards and commissions which are now doing engineering work for several different departments are to be abolished or transferred to the new Department of Public Works. It is hoped in this way to eliminate some of the red tape with which Government work is customarily burdened.

The American Association of Engineers has tabulated answers that educators and engineers have made to its questionnaire asking their opinion as to whether engineering, legal and other professional college courses should be preceded by one or two years of general collegiate training. Out of the total of 154 engineers who responded, 54 were deans, professors or instructors in engineering colleges, and the rest were principally consulting and chief engineers. The result was that 64 per cent favored two years of preparatory training and 28 per cent favored one year. Thus 92 per cent approved of at least some preparatory general education.

According to the Federal Trade Commission Wyoming is now the most important crude oil-producing state in the Rocky Mountain region. Its production in 1912 was about 1,570,000 bbl., in 1919 it was almost 13,630,000 bbl., and in 1920 it was probably 17,000,000 bbl.

It is planned to raise a loan of $973,300 for a hydro-electric plant on the Waikaremoana River, New Zealand, to provide current for the surrounding country and especially the City of Wairoa, which is in one of the most promising sections of New Zealand.

New Publications

MARINE ENGINEERS' HANDBOOK. Prepared by a staff of specialists. Editor in chief, Frank Ward Sterling, Lieutenant Commander, U. S. N. Published by McGraw-Hill Book Co., Inc., New York City, 1920. Flexible cloth; 4½ x 7 in.; 1,486 pages; illustrated. Price, $7.

This is a book for operating and designing engineers and students. In addition to containing the usual rules, tables and data given in engineers' pocketbooks, this handbook presents the leading branches of modern marine engineering in compact and convenient form without sacrificing clarity or completeness. The text is copiously illustrated and is divided into fifteen sections, each of which has been prepared by a specialist. Section 1 gives mathematical tables and formulas and mechanics of rigid bodies. Section 2, devoted to non-ferrous and ferrous metals, describes different processes of manufacture of iron and steel, mechanical and heat treatment, protective coatings, oxy-acetylene and thermit welding processes. A section devoted to fuels and combustion and oil-fuel burning covers composition, analysis and classification of solid and liquid fuels, fuel oil equipment, combustion and its analysis. Section 4, on marine boilers, covers their development, design, space, weight, settings, mountings, removal of scale, tests, and inspection requirements. The fifth section is devoted to turbines and mechanical reduction gears and the sixth treats of reciprocating engines. Section 7 treats of Diesel marine engines, their classification, operating processes, design and operation. There is a separate section on "Vacuum and Condensers," and Section 9 is devoted to ship forms and powering and screw propellers, and the following sections under "auxiliary machinery" include evaporators and distillers, feed-water heaters, oil coolers, centrifugal pumps, cntrifugal fans, heating and ventilating, ash-handling machinery, air compressors and deck auxiliaries. The succeeding sections cover the subjects of piping, valves and fittings; marine electrical installation; lubrication and lubricants; use of indicators and measuring horsepower of marine engines, together with a chapter on tests, trials and inspections, and the names and addresses of the leading societies, associations and commissions which have various functions utilized by marine engineers. In addition to a very full table of contents of the various sections there is a complete alphabetical subject index at the end of the book. The illustrations and diagrams are made to a scale compatible with the dimensions of the pages and have the merit of clearness and good proportions.

Personals

Hugh A. Brown has been appointed sales manager of the Electro Dynamic Co., with offices at the works in Bayonne, N. J.

T. B. Holmes, formerly with the Terry Steam Turbine Co. of Hartford, Conn., has taken a position as sales engineer with the K. B. Noble Co., of Hartford.

Stephen Thomas, formerly with the E. I. du Pont de Nemours & Co., of Wilmington, Del., as combustion engineer, has been appointed to the same position with Day & Zimmerman, Inc., of Philadelphia.

J. R. Lowe, previously with the Midwest Engine Co., has been appointed general sales manager of the Harrisburg Foundry and Machine Works, Harrisburg, Pa. This company, having completed its war work, is now making stationary engines of the piston-valve, Corliss-valve and "dual clearance" types, specializing on the last-named.

Society Affairs

Cleveland Section, A. S. M. E., will hold a joint meeting with the American Chemical Society on Jan. 25. Dr. W. Forsythe will speak on "The Pyrometer and High Temperature Measurements."

Colorado Section, A. S. M. E., will meet at the Metropole Hotel, Denver, on Jan. 28. "Industrial Expansion of Colorado" will be discussed by Charles C. Gates, president of the Gates Rubber Co.

The National Association of Stationary Engineers will hold the eleventh annual ball of the Combined Engineers of Brooklyn, N. Y., at 8 p.m., Jan. 29, at Imperial Hall, Red Hook Lane and Fulton St., near Borough Hall.

Washington Section, A. S. M. E., will hold a meeting Jan. 28 in the East Building, Bureau of Standards. Two illustrated lectures, "Wind Tunnels and Their Uses" and "Measurement of Air Resistance on Projectiles in Actual Flight," will be given, and the Bureau's wind tunnels will be inspected.

Metropolitan Section, A. S. M. E., will hold a joint meeting with the New York Section of the American Institute of Electrical Engineers in the Engineering Societies Building, New York City, on Jan. 28. Alfred E. Waller will be in charge and the subject will be "Marine Electrical Engineering." Papers will be presented on "Electricity Applied to Ship Auxiliaries," "Electrical Terminal Facilities," "Electric Ship Propulsion" and "Ship Propulsion."

Business Items

The Great Western Contracting Co., Kansas City, Mo., representative for the Conveyors Corporation of America, Chicago, has changed the name of its organization to the Rawlings Industrial Equipment Company.

The Kingsbury Machine Works is the name under which Albert Kingsbury will conduct his business of designing, manufacturing and selling his line of thrust bearings. The new office and factory is at 4314-24 Tackawanna St., Frankford, Philadelphia, Pa.

Miscellaneous News

The Leavitt Machine Co., Orange, Mass., has put out a new 48-page 7½ x 9½-in. catalog describing the Dexter valve-reseating machine, which is built in different sizes and for use on globe, gate and pump valves.

FUEL PRICES

BITUMINOUS

The following table shows the trend of the spot steam market in various coals (mine-run basis, f.o.b. mines):

	Nov., 1919*	Aug. 5, 1920	Jan. 6, 1921	Jan. 20 1921
Pittsburgh steam	$2.30	$10.00	$2.60	$2.50
Pittsburgh screened gas	2.30	12.00	3.15	3.50
Hocking	2.50	9.00	2.50	....
Franklin, Ill	2.35	6.50	3.00	2.85
Indiana 4th vein	2.35	7.50	2.75	2.50
Eastern Ohio, No. 8	2.35	10.50	2.75	2.75
Fairmont	2.50	13.50	2.40	2.15
Kanawha	2.60	14.00	2.80	2.70
S. E. Kentucky	3.00	10.50	2.90	2.80
Western Kentucky	2.35	5.25	2.60	2.25
Clearfield	2.95	12.00	3.25	2.85
Cambria and Somerset	2.95	13.50	4.35	3.60
New River	2.70	14.00	4.50	4.60
Pocahontas	2.35			

*Government prices.

DIESEL FUEL OIL

Philadelphia—In tank cars: 26@28 deg., 10c.; 30@34 deg., 12c.; 16@20 deg., 8c.

Cincinnati—In 8,000-gal tank cars; 26@28 deg., 6c.; 30@34 deg., 7c.

Cleveland—24@36 fuel oil, Group 3, $1.60 per bbl.; 30@34 gas oil, Group 3, 5½c. per gal.

New Construction

PROPOSED WORK

N. H., Hanover—Dartmouth College, c/o Bd. of Trustees, plans to build a memorial building on campus. About $250,000.

N. H., Manchester — The Orpheum Theater Co., c/o Park Theater, is having plans prepared for a theater building. About $250,000. T. W. Lamb, 644 8th Ave., New York City, Archt.

Mass., Boston—The J. F. Flagg Estate, 211 Nieuville Ave., is having plans prepared for an 8 story, 25 x 75 ft. mercantile building on Winter St. Parker, Thomas & Rice, 110 State St., Archts.

Mass., Needham (Boston P. O.) — The School Bd. received lowest bid for the installation of a steam heating system in the proposed new school on the Heights, from E. O. Burrows, 186 Franklin St., Boston, at $20,250.

Mass., Palmer — Memorial High School Comn. plans to build a 3 story high school. About $300,000. E. C. and G. C. Gardner, 33 Lyman St., Springfield, Archts.

Conn., Bridgeport—The Bd. Educ. is having plans prepared for two 3 story grade schools, one on South Ave. to cost $581,000 and the other on Grand St. to cost $442,000. L. Asheim, 211 State St., Archt.

N. Y., Far Rockaway — R. W. Rodman, Supt. of plant operation of the Bd. Educ., Room 515, Municipal Building, New York City, will receive bids until January 28, for installing heating, ventilating and temperature regulation apparatus in additions and alterations to Public School No. 39, here.

N. Y., New York—The Parnassus Club, 605 West 115th St., had sketches prepared for a 5 story, 50 x 200 ft. clubhouse including a steam heating system on West 57th St. About $1,000,000. Schwartz & Gross, 347 5th Ave., Archts. and Engrs.

N. J., Roseville (Newark P. O.)—J. Stern, Ordway Bldg., Newark, is having plans prepared for a theater here, including a steam heating system. About $500,000. Reilly & Hall, 405 Lexington Ave., New York City, Archts.

N. J., Rutherford—The Bd. Educ. had sketches prepared for a 2 story high school. About $250,000. Rasmussen & Wayland, 252 West 46th St., New York City, Archts. and Engrs.

Pa., Easton — G. Keister, Archt. and Engr., 56 West 45th St., New York City, is preparing preliminary plans for a 7 story, 60 x 200 ft. hotel and theater, including a steam heating system, at 22 Northampton St., here. Owner's name withheld.

Pa., Philadelphia—D. W. Griffith, 1476 Bway., New York City, is having plans prepared for a 4 story office building and theater including a steam heating system at Broad and Locust Sreets, here. About $750,000. F. Webber, Morris Bldg., Philadelphia, Archt.

Pa., Steelton—The finance committee of the City Council and the Water Dept. are planning to install one 30-hp. and one 150-hp. electric motors to pump water to filtering plant. Centrifugal pumps will also be installed. About $50,000. G. H. Roberts, Pres. of Water Dept.

Md., Annapolis—The Bureau of Yards & Docks, Navy Dept., Washington, D. C., received bids for boiler plant equipment and piping here, from H. A. Kries & Sons Co., 6 West Lombard St., New York City, $52,969; J. R. Proctor, 74 Cortland St., New York City, $53,980; W. G. Cornell Co., 923 12th St., N. W., Washington, D. C., $58,556. Noted Jan. 4.

Md., Baltimore — St. Mary's Industrial School, Wilkens Ave., is having plans prepared for administration building and tower including a steam heating system. About $500,000. H. I. Kavanagh, 913 North Calvert St., Archt.

Md., Baltimore—The Consolidated Gas, Electric Light & Power Co., Lexington Bldg., is having plans prepared for an addition to its power plant at Madison and Graves Sts. A. S. Loizeaux, Monument and Constitution Sts., Engr.

D. C., Washington—T. W. Lamb, Archt. and Engr., 644 8th Ave., New York City, preparing sketches for a theater and office building including a steam heating system on Connecticut Ave. About $850,000. Owner's name withheld.

W. Va., Charleston — The United Mine Workers, Coyle & Richardson Bldg., are having sketches prepared for a 6 story, 90 x 175 ft. hospital. About $500,000. Mills & Millspaugh, 67 East Long St., Columbus, O., Archts.

N. C., Asheville — The Clarence Barker Memorial Hospital plans to build a fireproof hospital. About $250,000.

Ala., Birmingham — The Birmingham Waterworks Co. is receiving bids for improvements including the installation of two 10,000,000 gal. turbine centrifugal pumps at Cahaba River pumping station, and two 500-hp. boilers, etc. About $400,000. H. Horner, Supt.

Tenn., Nashville—The Efficiency Apartment Corp., Ind. Life Bldg., plans to build an 8 story, 100 room apartment building. About $800,000. F. H. Frahn, Ind. Life Bldg., Archt.

O., Bay Village—The Northern Light & Power Co., c/o Mayor Wright, plans to build a power house. About $60,000.

O., Columbus—The City will be petitioned soon for an appropriation of about $80,000 for 2 high-pressure boilers, 2 stokers, etc., for light plant. Mr. Turner, Supt.

O., Columbus—Rowland Bros., 208 South High St., are having plans prepared for a 5 story, 62 x 187 ft. store and office building at 3rd and Broad Sts. About $350,000.

O., East Cleveland (Cleveland P. O.)—Dr. H. Spitzer, 902 Literary Rd., Cleveland, plans to build a 3 story store and apartment building here. About $300,000. T. C. Minor, 1832 East 79th St., Cleveland, Archt.

O., Forest—J. Herzog & Son are in the market for a 150- or a 200-hp., 440-volt motor.

O., Middletown—The Bd. Educ., M. E. Danford, Pres., is having plans prepared for two 2 story schools, one on Barles St. to cost about $300,000 and the other on Edgewood Ave. and 3rd St., about $350,000. T. D. McLaughlin, Lima, Archt.

O., Milford—The village will receive bids in about 2 months for motor driven centrifugal pumps or steam driven turbine pumps to be used in connection with the municipal waterworks. S. T. Bateman, Clk.

O., Xenia—The Bd. Educ., J. Beachum, Pres., is having plans prepared for a 2 story, 128 x 250 ft. high school on Church St. About $385,000. Pretzinger & Musselman, Dayton, Archts.

O., Youngstown—The Bd. Educ., 16 West Wood St., wil receive bids until February, for a 2 story, 250 x 250 ft. high school including a heating plant on Ohio St. C. F. Owsley, 1301 Mahoning Bank Bldg., Archt.

Ind., Indianapolis — The Bd. of School Comrs. plans to build a 2 story, 16 room, grade school on 28th St. About $346,000. Rubush & Hunter, 430 Amer. Central Life Bldg., Archts.

Ind., Upland — A. Fisherbuck, Trustee, Gas City, plans to build a 2 story, 72 x 113 ft. high school near here, including a steam heating system. About $650,000. E. I. Brown, Bluffton, Archt.

Mich., Detroit—The city is having tentative plans prepared for a civic center including city offices, memorial hall, auditorium and memorial tower. Steam heating equipment will be installed. About $3,000,000. A. Gould & Son, 610 Empire Bldg., Engrs.

Mich., Detroit—Park Davis & Co., Atwater St. and McDougal Ave., plans to build a 4 story, 100 x 200 ft. drug factory including a steam heating system. Electric power will be used for the operation of machinery. About $4,000,000. Smith, Hinchman & Grylls, 710 Washington Arcade, Archts. and Engrs.

Ill., Aurora—The Arney Co., Archts., 10 South La Salle St., Chicago, will receive bids about March 1 for a 10 story, 60 x 60 ft. bank and office building including a steam heating system. About $750,000. Owner's name withheld.

Ill., Chicago—Felt & Tarrant, 117 North Paulina St., are having plans prepared for two 7 story, 49 x 120 ft. factory buildings and a 60 x 100 ft. power house. Power equipment will be required. About $1,000,000. L. G. Hallberg & Co., 116 South Michigan Blvd., Archt.

Ill., Jacksonville—The City Council will receive bids until Jan. 31 for furnishing a mechanical stoker to be used on one 300-hp. O'Brien water tube boiler. The engine and blower to be furnished with the stoker to be large enough to operate stokers under a second boiler of the size mentioned above; and the entire instalation is to be arranged to allow for a duplicate unit at some future time under another boiler of like dimensions and in the same setting. Caldwell Engrg. Co., Engrs.

Wis., Kenosha—J. G. Rhode, 164 Market St. will receive bids in March for a 1 and 2 story theater on Main St. About $500,000. C. W. and G. L. Rapp, 190 North State St., Chicago, Ill., Archts.

Wis., Madison—The Madison Commercial Natl. Bank is having plans prepared for an 8 story bank and office building including a steam heating system. About $400,000. A. Moorman & Co., 6th Floor, Chamber of Commerce Bldg., St. Paul, Minn., Archt.

Wis., Milwaukee—The Sewage Comn. will readvertise soon for boiler and equipment for the Jones Island power house. Former bids rejected. T. C. Hatton, City Hall, Engr.

Iowa, Davenport — The Masonic Temple Assn., 337 Masonic Temple, had plans prepared for a 5 story lodge building including a steam heating system on 7th St. between Main and Brady Sts. About $1,000,000. Claussen & Kruse, 315 Central Office Bldg., Archts.

Iowa, Waterloo — The Masonic Temple Assn., J. D. Liffring, Pres., 312 1st Natl. Bank Bldg., plans to build a 6 story, 120 x 142 ft. temple including a steam heating system at Park Ave. and Mulberry St. About $300,000. Architect not announced.

Minn., Minneapolis—J. H. Davidson, Agt., 723 Plymouth Bldg., is having plans prepared for a 3 story, 186 x 200 ft. apartment building including a steam heating system on Lake Harriet Blvd. A. Dahlstrom, 305 Essex Bldg., Archt.

S. D., Sioux Falls—The Bd. Educ., H. S. Hilleboe, Supt., ordered plans prepared for a 3 or 4 story high school including a steam heating system. About $400,000. Perkins & McWayne, 324 Paulton Block, Archts.

Mont., Butte—The State School of Mines, C. H. Clapp, Pres., plans to build a 3 story college building including a steam heating system. About $250,000. Architect not announced.

Mo., St. Louis—The United Railways Co., 39th and Park Aves., plans to build four 40 x 40 ft. substations of 1,000 kw. each, and change two existing substations from a.c. to d.c. giving each a capacity of 2,000 kw. Rotary converters and control equipment will be installed. About $285,000. W. E. Bryan, 39th and Park Aves., Engr.

Col., Matheson — The Farmers' Electric Light, Power & Coal Co., incorporated for $100,000, plans to build a power plant to supply four towns. O. M. White, Pres. of the State Bank of Matheson heads the company.

Cal., Los Angeles—The Bd. Educ. is having plans prepared for a school on 4th and Fickett Sts. About $500,000. J. C. Austin, Baker-Detwiler Bldg., Archt.

Cal., Los Angeles—The Santa Fe R.R. Co., Kerchoff Bldg., will soon award the contract for a 4 story, 85 x 275 ft. ice plant at Hobart Station. About $500,000. C. W. Felt, Chief Engr. and W. H. Mohr, Archt., both at Kerchoff Bldg.

Cal., Los Angeles—The Los Angeles Railroad Co., Pacific Electric Bldg., plans to build 4 new sub-stations to cost $500,000; reconstruct tracks and purchase new equipment, $1,600,000 and renew overhead equipment, $300,000.

Cal., Sawtelle—The U. S. Soldiers' Home, Major F. T. Baggott, Treas., will soon award the contract for two 2 story, 54 x 364 ft. hospital buildings including a steam heating system. W. A. Munsell, 444 Douglas Bldg., Archt.

Que., Montreal West—The city voted to expend $117,000 to provide for a new electric light system with underground conduits.

Que., Verdun—The city plans an election to vote on building a municipal ice plant and an incinerator plant. About $150,000.

Ont., Brantford — The Hydro-Electric Comn. of Ontario, University Ave., Toronto, plans to duplicate the present hydro-electric system here. Plans include a substation, pole lines, distribution system, etc. About $750,000. F. A. Gaby, above address, Chief Engr.

Ont., London—The Bd. Educ., R. M. McElheran, will open bids about March 1 for a 2 story, 200 x 240 collegiate building including a steam heating system on Waterloo St. About $600,000. L. E. Carrothers, c/o Bd. Educ., Archt.

Ont., London — The Bd. of Governors, A. T. Little, Pres., will receive bids in March for a 2 story, 85 x 320 ft. university including a steam heating system on North London St. About $500,000. Col. W. J. Brown, Western University, Archt.

B. C., Victoria — The Minister of Pub. Wks. will receive bids until February 7 for two 20,000 Imp. g.p.m. centrifugal pumps J. A. Wilson, Engr.

CONTRACTS AWARDED

Mass., Boston—The Ginter Co., Lessee, 369 Congress St., has awarded the contract for an 8 story store and business building including a steam heating system to L. D. Willicut & Sons Co., 146 Summer St. About $500,000.

Mass., Fall River—The Quequechan River Comn. has awarded the contract for the superstructure of a dam and the foundation of a pumping plant at Watuppa Pond to R. H. Beattie, Buffington Bldg., at $87,209. Noted Oct. 19.

Mass., Taunton—The city has awarded the contract for the reconstruction of the boiler room and alterations in the engine room of the municipal electric lighting plant to Simpson Bros. Corp., 77 Summer St., Boston, at $48,930.

Conn., Hartford — Bryant & Chapman, Woodland St., has awarded the contract for a 20 x 30 ft. power plant to C. N. Flagg & Co., 27 State St., Meriden. About $10,000. Noted Feb. 2.

N. Y., Brooklyn—Rubel Bros., Glenmore Ave., will build an ice plant on Tilden Ave. between Flatbush and Bedford Aves. About $500,000. Work will be done by day labor.

Pa., Byberry (Philadelphia P. O.)—The Hospital for the Insane has awarded the contract for a 25 x 85 ft. addition to power house to G. H. Evans, 45 North 13th St., Philadelphia. About $5,000.

D. C., Washington—The Washington Ice Mfg. Co., 3327 K St., N. W., has awarded the contract for an ice manufacturing plant at 1233 23rd St., to Lake Stone Co., Bank of Commerce Bldg., 7th and E Sts., N. W., at $50,000. Noted Oct. 12.

S. C., Charleston—The Bureau of Yards and Docks, Navy Dept., Washington, D. C., has awarded the contract for boiler plant improvements at the navy yard here, to Carroll Electric Co., 714 12th St., N. W., Washington, D. C., at $87,900. Noted Jan. 18.

Tenn., Manchester—The city has awarded the contract for a waterworks system including a 60,000 gal. reservoir tank, a 250 g.p.m. pump and a 20-hp. oil engine, to J. B. McCrary Engrg. Co., 3rd Natl. Bank Bldg., Atlanta, Ga., at $40,080.

O., Cleveland—The City Ice Delivery Co., H. D. Norval, Mgr., Cadillac Bldg., has awarded the contract for a 1 story, 65 x 140 ft. ice plant on Saranac Rd. to Younger & Farmer, 1670 Crawford Rd. About $75,000. Noted Jan. 11.

Ill., Chicago—The Commonwealth Edison Company, 72 West Adams St., has awarded the contract for the superstructure of a 3 story, 296 x 310 ft. power plant to generate 200,000 kw., at 100th St. and Commercial Ave., to G. A. Fuller & Co., 140 South Dearborn St. About $5,000,000. Noted Nov. 9.

Tex., Denison — The Denison Hotel Co. has awarded the contract for a 4 story hotel to Munn Constr. Co., S. W. Life Bldg., Dallas. A steam heating system will be installed in same. About $300,000.

Wash., Seattle — The Sound Constr. & Engr. Co., Lowman Bldg., has sublet contract for the installation of a plumbing and ventilating system and boiler plant in the telephone exchange here, for the Pacific Telephone & Telegraph Company, San Francisco, Cal., to the Eckart Plbg. & Htg. Co., 1614 3rd Ave., Seattle, Wash., at $180,000. Noted Nov. 30.

Cal., Los Angeles — The Union Bank & Trust Co., 740 South Bway., has awarded the contract for a 6 story, 60 x 110 ft. bank building at 8th and Hill Sts., to J. V. McNeil, H. W. Hellman Bldg., at $240,000. A steam heating system will be installed in same.

Cal. Los Angeles — The Los Angeles Pressed Brick Co., Frost Bldg., has awarded the contract for a 1 story, 93 x 198 ft. storage building at 952 Date St., to J. V. McNeil, H. W. Hellman Bldg. About $40,000. A mono-rail system will be installed in same at a cost of $30,000. Also conveyors, hoisting machinery, compressors, etc., cost $30,000.

"Opportunity" Advertising:
Think "SEARCHLIGHT" First!